A QUANTITATIVE MODEL FOR PREDICTING THE ACCURACY OF EARLY COST ESTIMATES FOR CONSTRUCTION PROJECTS IN THE PROCESS INDUSTRY

By

STEVEN MICHAEL TROST

Bachelor of Science
Massachusetts Institute of Technology
Cambridge, Massachusetts
1991

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1996

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
December, 1998

A QUANTITATIVE MODEL FOR PREDICTING THE

ACCURACY OF EARLY COST ESTIMATES FOR

CONSTRUCTION PROJECTS IN THE

PROCESS INDUSTRY

Thesis Approved:

Gerald D. Oberlender
Thesis Advisor

Robert K. Hughes

Dana Hobson

[illegible]

Carla L. Goad

Wayne B. Powell
Dean of the Graduate College

ACKNOWLEDGMENTS

This research effort could not have been successful without the dedication and generous support of numerous individuals and organizations to whom I am greatly indebted. I would like to express my deep appreciation to Dr. Garold Oberlender, my thesis advisor and principal investigator of the research team. Dr. Oberlender provided countless hours of guidance, encouragement and constructive criticism. Thank you for your unparalleled professionalism and dedication. I also wish to thank the members of Construction Industry Institute's Research Team #131. The benefits of their professional guidance and input to this research effort are immeasurable. I offer a special thanks to Mr. Karl Sturm, the industry chairman of the research team.

My appreciation goes out to the faculty members of Oklahoma State University who gladly and willingly served on my graduate committee–Dr. Carla L. Goad, Dr. Dana Hobson, Dr. Robert K. Hughes and Dr. Rick Wilson. In addition, I would like to thank Mr. Sankar Raman for his assistance in the development of the prototype for ESP.

I extend a heartfelt thank you to my beautiful wife, Sarah, for her loving support and ongoing encouragement and patience. Thank you for helping to keep my life in balance. I would also like to thank my mother, Mrs. Jeannine Nelson and my father, Mr. Michael Trost. Your sacrificial support of my undergraduate education has helped to make this possible. Finally, thank you, Lord Jesus for granting me the ability to accomplish this endeavor and, most of all, for your precious gift of eternal life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Background

Early estimates are critical to the initial decision-making processes for the construction of capital projects. As such, the importance of early estimates to owners and their project teams cannot be overemphasized. The initial cost estimates form the basis to which all future estimates are compared. Future estimates are often expected to agree with (i.e. be equal to or less than) the initial estimates. Yet, all too often, final project costs exceed the initial estimates. In addition, the level of cost overrun or underrun during construction is often used to measure the performance of the project manager and the project team as well as the overall success of the project. However, if an early estimate is extremely inaccurate, a properly designed and properly executed project may appear to be a failure.

Previously, there have been few quantitative, objective methods to evaluate the accuracy of early estimates. In recognition of the importance of early estimates and this lack of quantitative metrics for estimate accuracy, the Construction Industry Institute (CII) decided in 1996 to establish a research team to investigate ways to improve early estimates. Based on its mission, the research team was given the moniker "Improving Early Estimates" and this report presents the results of that research effort.

Purpose

The "Improving Early Estimates" research team was formed from the realization that early estimates drive the business unit decisions during the early stages of a project. As such, early estimates often provide the basis for whether or not a project receives funding. A stark contrast arises when comparing the extreme importance of early estimates with the amount of information typically available during the preparation of an early estimate. Such a lack of scope definition often leads to questionable accuracy regarding the estimate. Even so, early estimates (accurate or not) often become "cast-in-stone" with future estimates expected to agree with the early estimate.

Objectives

The research team was established with three primary objectives. The first objective was to develop a procedure to score an early estimate in order to assess the thoroughness, quality and accuracy of the estimate. The procedure would be used to score early estimates of completed construction projects. These projects and their estimate scores would be used to determine the correlation between estimated and final costs.

A second objective was to develop a computer model that could be effectively used to implement and streamline the estimate score procedure. In essence, these first two objectives sought to reduce the subjectivity involved in assessing the accuracy of early estimates by establishing a quantitative model and procedure.

The final objective was to develop a "Best Practices Guide" to capture the experience and wisdom of the research team and to document the best practices being employed by their respective firms and other firms in the industry. The *Improving Early Estimates—Best Practices Guide* contains the processes, procedures, techniques and checklists that have been successfully used to prepare early estimates emphasizing what works, what does not work, precautions and pitfalls (25).

Scope

In order to achieve the stated purpose and objectives of this study, quantitative data were collected from completed construction projects in the process industry. Current CII membership predominantly centers around the process industry, which includes petroleum and metals refining, chemical and pharmaceutical manufacturing, pulp and paper production and power generation. In addition, this research team was formed in part to expand upon the work of a former research team (CII's "Pre-Project Planning" research team). The "Pre-Project Planning" research team had identified seventy elements used to rate the level of scope definition that exists for a construction project in the process industry. The seventy elements were called the Project Definition Rating Index (PDRI). The "Improving Early Estimates" team sought to identify which of those seventy elements are important to the accuracy of an early estimate and to identify additional (non-scope) elements that may influence estimate accuracy as well.

The study was conducted in two phases. The initial phase involved the development of a questionnaire to collect estimated and actual cost data as well as information related to the accuracy and completeness of early estimates for completed construction projects around the world. The questionnaire was developed not only for the purposes of initial data collection but also to function as the basis for the estimate score procedure mentioned above. Responses were received from twenty-seven different companies representing eighty-nine construction projects totaling $6.1 billion.

The second phase was completed as a three-step process. Data were collected from completed construction projects using the questionnaire developed during the initial phase. The data were analyzed in order to determine suitable weighting factors to be used in the estimate score procedure. Finally, a computer software program was developed to implement the estimate score procedure and thus model and predict estimate accuracy based on the score of an early estimate. This prediction is based on the comparison of the estimate score with the estimate scores and cost performance of previously completed construction projects.

Chapter II discusses previous work that has been performed relating to early estimates and cost performance of construction projects. Chapter III describes the questionnaire development and data collection processes. The data analysis methods are described in Chapter IV. The data analysis results are discussed in Chapter V and the implementation of the results, including the development of the computer software program, forms the basis of Chapter VI. Finally, Chapter VII reports the summary and conclusions of the study as well as recommendations for further research.

Definitions

The research team recognized ealry the importance of properly defining the term “early estimate”. Does the term merely refer to the infamous “back-of-the-envelope” estimate? Does it refer only to preliminary or conceptual estimates? Does it refer to the full funding estimate? The Construction Industry Institute (CII) and the Association for the Advancement of Cost Engineering International (AACE) have published recommended practices for defining the stages of cost estimates (1, 24). Table 1 and Table 2 present their recommendations.

Table 1 – CII Cost Estimate Definitions (CII 6-2)

Estimate Class	Accuracy	Description
*Order-of-Magnitude	+/- 50%	Feasibility Study - cost curves
*Factored Estimate	+/- 30%	Major Equipment - factored
Control Estimate	+/- 15%	Quantity Based
Detailed or Definitive	+/- 10%	Based on Detailed Drawings

* considered *early* estimates

Table 2 – AACE Cost Estimate Definitions (18R-97)

Estimate Class	Accuracy	Description
*Class 5	-50% to +100%	Concept Screening
*Class 4	-30% to +50%	Study or Feasibility
*Class 3	-20% to +30%	Budget, Authorization, or Control
Class 2	-15% to +20%	Control or Bid/Tender
Class 1	-10% to +15%	Check Estimate or Bid/Tender

* considered *early* estimates

After much discussion and deliberation, the research team concluded that each firm and organization has its own set of definitions and nomenclatures regarding early estimates and, in addition, each firm approves full funding at different stages of a project. As a result, the team decided to define an early estimate (as related to this research effort) as "any estimate that has been prepared from inception of the project up to and including funding approval".

"Contingency" was also a term that received much discussion. The team agreed that several different types of "contingency" exist, some of which are not truly contingency. For instance, rare, unexpected and unforeseeable events such as floods, earthquakes and labor strikes should not be covered by contingency funds but rather by insurance. Similarly, items that are known to be required should not be covered by contingency but by appropriate allowances. "Contingency" as it relates to this research refers to funds above and beyond the base estimate that are set aside to cover issues such as pricing uncertainty, scope omissions and errors and escalation uncertainty. As such, contingency should not be included for discretionary scope changes but would apply to non-discretionary scope changes.

"Cost overrun" refers to the amount of contingency that *should* have been applied to the base estimate to achieve zero overall cost growth. This term essentially refers to the inverse of the accuracy of the *base estimate*. In essence, a large cost overrun refers to an inaccurate base estimate and vice versa.

CHAPTER II

REVIEW OF LITERATURE

The accuracy of conceptual cost estimates for capital projects has been a major concern and a subject of much scrutiny over the last thirty years. In 1965, Hackney published a checklist for establishing a detailed definition rating for capital projects (13). Hackney proposed the use of the definition checklist for applying contingency to capital cost estimates. Hackney validated the checklist by comparing the definition ratings of thirty projects to their respective levels of cost overrun (12). Hackney later revised the checklist to specifically address process projects and developed a separate checklist to apply the definition rating method specifically to hazardous waste remedial projects (11).

In the late 1970s, the U. S. Department of Energy recognized the importance of accurate conceptual cost estimates and contracted the Rand Corporation to study the capital cost estimation problems associated with pioneer energy process plants (18, 19, 20). During the study, Merrow determined that 74% of cost growth is caused by underestimation (i.e. improper estimation). Merrow concluded that capital costs are repeatedly underestimated for advanced chemical process facilities and that cost and performance shortfalls can be explained by what is known about the process technology and what is included in the project estimate. As such, he concluded that the factors contributing to poor estimates and poor performance can be identified early in the development of the technology. Merrow developed a model to predict cost growth based on forty-four completed pioneer process plants. The model predicted that expected cost growth for pioneer process plants could be determined early in project development as a function of the percent of unproven technology, difficulties experienced with process impurities during process development, the number of process steps, percent of checklist items included in the estimate and site-specific project definition. Merrow stated that the model accounted for 83% of the variability in the project data. Merrow recommended continued research through the development of a detailed database of advanced process plant projects undertaken by the chemical, oil and minerals industries in North America to test a range of hypotheses about the factors affecting cost and performance estimation (20).

While the Rand Corporation was working for the Department of Energy to study the accuracy of early project estimates, Southern Company Services (SCS) began an in-house analysis of estimate accuracy in an effort to develop a consistent and reliable system for applying meaningful contingency to project cost estimates (29). SCS identified three types of contingency to include in their system (pricing, scope omission and error and escalation) and three types of contingency to exclude (schedule changes, scope expansion and acts of God). For pricing contingency, the SCS system utilizes range-estimating techniques in conjunction with Monte Carlo simulation software. Regarding scope omission and error, SCS applies a standard percentage based on a grid of percent engineering complete versus scope source confidence. SCS periodically updates the grid as additional project data become available. For the final contingency item, escalation, SCS utilizes an annual report on anticipated escalation published by the Southern Electric System.

In 1985, Bakewell proposed three prominent determinants of accuracy for conceptual estimates–scope definition, estimator experience level and accuracy of the cost information database (2). However, no definitive analysis for validating or quantifying the relative importance of those factors was performed.

In 1986, Wright and Hill outlined the efforts undertaken by British Petroleum (BP) to deal with the abounding uncertainties associated with conceptual capital cost estimating (36). BP addressed the problems of uncertainty in two ways. First, BP sought improved methods of forecasting future competitive activity and the effects of economic market activity on project costs. Second, BP endeavored to develop probabilistic techniques for appraising cost estimate accuracy. BP's efforts to appraise cost estimate accuracy led to the development of a probabilistic range estimating system called BRISK. The inputs to BRISK include project definition variables and independent cost variables. The project definition variables and their distributions are selected from a table that relates project definition to estimate class and confidence in the information source. The distributions of the cost variables are selected from tables relating to cost type and confidence. The cost estimator uses BRISK to establish contingency based upon the level of scope definition, the individual cost items, and their respective uncertainties (36). In 1988, Stevens and Davis reported on the use and ongoing validation of BRISK, but only two major BRISK-analyzed projects had been completed at that time (28).

In 1988, Skitmore performed an exhaustive review of empirical studies relating estimating accuracy to its contributing factors (27). Skitmore summarized the results of various studies comparing the effects of factors such as type of project, size of contract, geographical location, number of bidders, ability of the estimators, level of information available and state of the market. In addition to summarizing past studies, Skitmore performed an additional analysis to compare the influence of factors such as yearly trends, floor area, building type, type of construction, contract sum, contract period, number of bidders, individual estimators, scope of design and basic plan shape. Skitmore acknowledges the apparent trends relating estimate accuracy to various factors such as market conditions, project size, number of bidders, amount of design information and estimator ability. However, Skitmore did not endeavor to quantify the results into a theory or model but rather sought to present the individual results of the various studies involved, along with the results of his own research regarding contributing factors to estimate accuracy (27).

In 1988, the Federal Construction Council commissioned the Building Research Board to study federal construction estimating practices and to recommend techniques for improving the accuracy of early cost estimates. The Building Research Board identified three recommendations for improving federal estimating procedures. The Board recommended developing standard terminology and formats for budgets and estimates, taking steps to ensure that estimators are properly qualified for conceptual estimating and expanding the use of parametric and probabilistic estimating techniques for conceptual estimates (22).

In 1991, Merrow and Schroeder reported the findings of a study conducted for the World Bank to assess the reasonableness of conceptual cost and schedule estimates and the potential for cost growth and schedule slip for hydroelectric projects (21). Merrow and Schroeder performed a statistical analysis on fifty-six hydroelectric projects comparing cost and schedule performance to several potential causes of cost problems. Merrow and Schroeder developed a regression cost model relating total capital cost to megawatts of installed capacity, hydraulic head, whether the project represents an expansion or a new site, the height of the dam and the year of project appraisal. After the presentation of the aforementioned model, Merrow and Schroeder warned, "no statistically based system will substitute for judgment and experience in the project team."

In 1993, Parker reported sample responses to questions related to budgeting and cost control (26). The questions and responses were as follows:

How can budgets be wrong at the start?

- owner requirements were not fully known
- initial planning and design programming were inadequate
- the design and construction schedule was not established
- estimators obtained requirements in piecemeal fashion
- too many requirements were lump summed; requirements should have been better defined
- owner politics forced budgets to match a predetermined figure rather than reflect actual requirements

How can budgets go astray after approval?

- misunderstanding of project scope between owner and users
- failure to clearly communicate requirements to the designer
- failure to control the designer

- inability to control user changes
- failure to properly evaluate cost of design during reviews
- not meeting schedule

In 1991, the Construction Industry Institute assembled a research team to study the impact of pre-project planning on the overall project success of capital projects (9). The team sought to quantify the impact by establishing a Success Index Value for rating project success. This value was computed and compared to a Pre-Project Planning Index Value for a variety of projects (8). In 1995, Gibson and Dumont established another quantifiable index value, the Project Definition Rating Index (PDRI) (developed to both mirror and expand upon Hackney's definition rating checklist) and compared the value with the Success Index Value (7, 8). Gibson and Dumont performed validation of the PDRI on twenty-nine projects and found that 42% of the variation in the Success Index Value could be explained by the PDRI.

In 1993, the U. S. Department of Energy commissioned Independent Project Analysis, Inc. (IPA) to perform a quantitative project performance study on how well The Office of Environmental Restoration and Waste Management develops and executes environmental remediation and waste management projects. IPA utilized its own proprietary databases of over 550 completed capital projects and over 230 completed environmental remediation projects. IPA collected over 1,000 pieces of information for each project in the databases and each project in the study. The information collected fell into the following categories: general information, assessment activities, remediation characteristics, technology, project management, engineering practices, estimate data, project results, external/regulatory issues and general comments. “Estimate data” collected included estimated cost, estimated schedule, contingency and escalation figures, project definition items and estimating methods. IPA sought to link project inputs with project outputs by utilizing parametric statistical methods. IPA determined that good cost and schedule performance are dependent upon the level of project definition, regulatory coordination, the number of major design changes, project management practices and the use of industry “best practices”. IPA found that the level of project definition could explain 50% of the cost growth in environmental remediation projects. The results of IPA’s study were largely qualitative and no model was published for calculating or predicting contingency or cost growth (31).

In 1994, Hollmann reported on the development of a cost estimating system by Eastman Kodak’s Capital Estimating Department to address problems associated with inconsistent estimating methods between strategic and conceptual estimating stages. Eastman Kodak developed the cost-estimating tool to bring simplicity, consistency, accuracy and efficiency to its strategic and conceptual cost estimating processes (15, 16).

In 1994, El-Choum compared thirty-seven parameters that were deemed potential contributors to construction cost overruns. El-Choum performed a multivariate factor analysis of the thirty-seven parameters to establish which variables provide the strongest correlation. El-Choum determined that the primary contributors are estimate preparation, design changes, processing modification, activity sequencing, legal problems, morale/motivation, social influence, political influence, feedback procedure and improper supervision and developed a model relating the factors to construction cost overruns (5, 6).

CHAPTER III

DATA COLLECTION

Initial Questionnaire Development

The team initially sought to identify the PDRI elements that relate to early estimates and, in particular, those that relate to the accuracy of early estimates. The team identified forty-six of the seventy elements that could potentially impact the accuracy of an early estimate. In addition, the team identified thirty-four additional elements that are not directly related to scope definition but have the potential for influencing estimate accuracy.

After the individual elements were identified, a rating scale for each element was determined. The "Pre-Project Planning" research team had developed a brief description for each of the seventy PDRI elements. The PDRI questionnaire respondents had been asked to rate the elements from one to five, with one as "best" and five as "worst". The respondents were also allowed to rate an element as zero for "Not Applicable" if an element did not apply to their particular project. The one-to-five rating scale conforms to a Likert scale and thus does not force the respondent to rate a particular element "good" or "bad" but allows a neutral response. The same one-to-five rating scale was chosen by this research team for consistency with the PDRI data and in recognition of the benefits of using a Likert scale.

The team then proceeded to develop descriptions for each of the additional elements not contained in the original PDRI questionnaire. Recognizing that a certain amount of subjectivity would still be involved in rating the elements (e.g. a rating of "two" to one person may not be same as a "two" to someone else), the research team developed suggested ratings for each of the possible responses for each of the new elements. The "Pre-Project Planning" research team had developed a single, generic suggested rating to apply to all of the seventy PDRI elements.

A two-page questionnaire was then compiled that contained the elements to be rated on one side (including the PDRI score) and requested specific project and cost data on the reverse side. Cost data were requested in the form of both estimated and actual costs. As a part of the estimated cost data, the respondents were asked to list separately the amount of contingency that had been applied to the estimate. Having the contingency amount broken out separately was necessary to enable comparisons between the base estimate and the actual costs. Additional cost data were requested as well, including bulk materials, engineered equipment, engineering design and construction. Due to the limited amount of detailed cost data received, analysis of the detailed cost data was not performed. Figure 1 shows the cost information side of the initial data collection questionnaire.

Cost Information Data for Estimate Score

Contact Person:__________________________ **Contact Phone #:**____________

Company:__________________________ **Your Project ID:**____________

Principal Type of Project :

Industrial	(Future Research) Infrastructure	(Future Research) Building
___Electrical (Generating)	___Electrical Distribution	___Lowrise Office
___Oil Exploration/Production	___Highway	___Highrise Office
___Oil Refining	___Navigation	___Warehouse
___Pulp and Paper	___Flood Control	___Hospital
___Chemical Mfgr.	___Rail	___Laboratory
___Environmental	___Water/Wastewater	___School
___Pharmaceuticals Mfgr.	___Airport	___Prison
___Metals Refining/Processing	___Tunneling	
___Microelectronics Mfgr.		
___Consumer Products Mfgr.		

Other (Please describe):__________________________

This project was: Grass Roots _______ Modernization _______ Add-On _____
Other (Please describe) ____________________

Owner:__________________________
General Contractor:__________________________
A/E Firm(s):__________________________

Capital Cost Category	Estimated Costs	Actual Costs
Engineering Design	________	________
Engineered Equipment	________	________
Bulk Materials	________	________
Construction	________	________
Owner's Costs	________	________
Other (Describe)	________	________
Contingency	________	N/A
Total Project Costs	________	________
	(Date:__________)	(Date:__________)

- **At the time this estimate was prepared, provide the approximate %-complete of the following:**

  ___ Business Unit Study → (%)
  ___ Preliminary Engineering → (%)
  ___ Detailed Engineering → (%)
  ___ Procurement → (%)
  ___ Construction → (%)

- **What was the single biggest factor affecting the difference between the estimated and actual costs?** ______________________________

- **Any remarks or comments:** ______________________________

Figure 1 – Initial Cost Information Questionnaire

Initial Data Collection

The "Pre-Project Planning" research team had collected data on approximately thirty projects. These projects were the initial focus of this team's data collection efforts. A cover letter was mailed along with the questionnaire and element descriptions to each of the previous PDRI respondents. The respondents to the PDRI questionnaire had already rated the seventy PDRI elements and therefore only needed to rate the thirty-four non-PDRI elements to be included in this research effort. Twenty-two of the previous PDRI respondents completed the questionnaire. In addition to the PDRI respondents, each of the team members took a copy of the questionnaire and element descriptions to his individual organization to collect additional project data. The initial research team contribution resulted in twenty-five projects, bringing the total to forty-seven projects for the initial data collection effort.

Preliminary Data Analysis and Questionnaire Refinement

Of the initial forty-seven data points, nine did not have contingency broken out as a separate item and therefore could not be used in the analysis. In addition, one of the projects did not pertain to the process industry and two of the projects were deemed to be unusable due to considerable discretionary scope growth that took place after the estimate was performed. Preliminary data analysis of the resulting thirty-five projects readily identified the need for additional data. Reliable conclusions simply could not be obtained from statistical analysis of 104 variables and only thirty-five observations. As a result, the team exerted considerable effort to both reduce the number of variables and increase the number of observations.

To reduce the number of variables, the team reviewed the initial forty-six PDRI elements that had been identified as having a potential to influence early estimates. This list was compared to the twenty-three elements of the "PDRI short list" that had been developed by the CII Benchmarking Team in conjunction with Dr. Edd Gibson, the principle investigator of the "Pre-Project Planning" research team. The twenty-three-element PDRI short list had been developed to capture the major scope definition drivers while facilitating a shorter questionnaire response time. The comparison between the two lists yielded eighteen elements. The team felt the list could still be shorter and through mutual deliberation and discussion, reduced the number to thirteen. In addition, one element (*project schedule*) which did not appear on the PDRI short list was deemed important enough to include in the final list, thus bringing the total to fourteen.

The complete list of elements was grouped into four divisions. Division 1 represents *who* was involved in preparing the estimate. Division 2 refers to *how* the estimate was prepared. Division 3 involves *what* was known about the project (i.e. the fourteen elements adapted from the PDRI) and Division 4 represents *other factors* affecting the estimate.

The team eliminated one Division 4 element (*degree of modularization and prefabrication*) and combined four of the initial Division 4 elements into two elements (*foreign governmental requirements* and *domestic governmental requirements* became *governmental requirements*; *logistics for engineering* and *logistics for construction* became *logistics for engineering and construction*), reducing the Division 4 total from fourteen to eleven. The final element count was then forty-five. At this time, suggested ratings for the fourteen Division 3 elements were formulated based on the generic suggested ratings from the original PDRI definitions. In addition, the elements requiring "Yes/No" responses on the original PDRI questionnaire were expanded to allow a range of responses from one to five. The element descriptions and suggested ratings for each of the forty-five elements are given in Appendix A. Figure 2 shows the cost information portion of the revised questionnaire. The reverse side of the revised questionnaire (Figure 3) lists the forty-five elements grouped into four divisions.

The team set a goal to collect at least twenty observations more than the number of variables. With forty-five variables and thirty-five usable projects, thirty additional projects would be needed.

Secondary Data Collection

To obtain additional project data, the research team members went back to their individual organizations with the revised questionnaire and obtained another twenty-seven observations. Additional projects were also requested from other CII member companies. The cost information portion of the questionnaire was shortened to facilitate quicker preparation time for the respondents. Since analysis of cost data in this research was to be performed on the base estimate, the minimal requirement for cost data was the base estimate *without contingency* and the actual final costs.

Cost Information Sheet

Contact Person: ______________________ **Contact Phone #:** ______________________

Company: ______________________ **Your Project ID:** ______________________

Type of Project :

- ____ Electrical (Generating)
- ____ Oil Exploration/Production
- ____ Oil Refining
- ____ Pulp and Paper
- ____ Chemical Manufacturing
- ___ Environmental
- ___ Pharmaceuticals Manufacturing
- ___ Metals Refining/Processing
- ___ Microelectronics Manufacturing
- ___ Consumer Products Manufacturing

Cost Category	**Cost in $1 million**
Base Estimate	______________
Contingency	______________
Actual Cost (TIC)	______________

Base estimate *without contingency*, prepared after the business unit, but before completion of detailed engineering.

- **At the time this estimate was prepared, the approximate %-complete for each of the following:**

—— Business Unit Study → (%)

—— Preliminary Engineering → (%)

—— Detailed Engineering → (%)

- **Were there any significant factors that affected the difference between the base estimate and the final cost of the project? Such as:**

  Acts of God, such as earthquake, etc.? Yes ____ No ____

  Significant changes in project scope? Yes ____ No ____

  Other, please explain. ______________________

- **Any remarks or comments:**

____

____

____

____

Any questions, please contact:

Steve Trost
Ph (405) 372-2336
Fax (405) 743-3799
SteveTrost@alum.MIT.edu

or

Dr. Garold Oberlender
Ph (405) 744-5189
Fax (405) 744-7554
Oberlender@aol.com

Figure 2 – Cost Information Portion of Revised Questionnaire

DIVISION 1 -- WHO WAS INVOLVED IN PREPARING THE ESTIMATE?	1 (Best)	2	3	4	5 (Worst)
1.1 Owner's experience level					
1.2 Engineer/Designer's experience level					
1.3 Relevant experience of the estimating team					
1.4 Level of involvement of the project manager					
1.5 Involvement of other resources in preparing estimate					
1.6 Review and acceptance of estimate by appropriate parties					
1.7 Level of team integration and alignment					
1.8 Purpose and intended use of estimate					
1.9 Attitude/culture toward changes					

DIVISION 2 -- HOW WAS THE ESTIMATE PREPARED?	1 (Best)	2	3	4	5 (Worst)
2.1 Completeness of cost information					
2.2 Applicability of cost information					
2.3 Accuracy and reliability of cost information					
2.4 Standard procedure for updating cost information					
2.5 Time allowed for preparing the estimate					
2.6 Alignment of estimate methodology with available project information					
2.7 Is the estimating work process formally defined and followed?					
2.8 Formal structure to categorize and prepare the cost estimate					
2.9 Utilization of check lists to ensure completeness and technical basis					
2.10 Documentation of information used in preparing the estimate					
2.11 Method used to determine contingency					

DIVISION 3 -- WHAT WAS KNOWN ABOUT THE PROJECT?	1 (Best)	2	3	4	5 (Worst)
3.1 Capacities					
3.2 Technology					
3.3 Processes					
3.4 Site location					
3.5 Plot plan					
3.6 Utility sources and supply conditions					
3.7 Environmental assessment					
3.8 Process flow sheets					
3.9 Mechanical equipment list					
3.10 Heat and material balances					
3.11 P&ID's					
3.12 Project strategy					
3.13 Project design criteria					
3.14 Project schedule					

DIVISION 4 -- FACTORS CONSIDERED WHILE PREPARING THE ESTIMATE	1 (Best)	2	3	4	5 (Worst)
4.1 Owner's costs					
4.2 Impact of project classification					
4.3 Impact of contract type					
4.4 Impact of project schedule					
4.5 Impact of governmental requirements					
4.6 Work force					
4.7 Labor productivity					
4.8 Bidding climate					
4.9 Taxes and insurance					
4.10 Money factors					
4.11 Logistics for engineering and construction					

Figure 3 – Estimate Score Portion of Revised Questionnaire

This combined "second effort" yielded forty-two additional projects. Ten of the new projects could not be used because they did not pertain to the process industry and four could not be used due to significant discretionary scope changes that could not be adequately quantified. In addition two did not have the contingency amount separated. However, six of the nine projects from the initial data collection effort were deemed usable after contingency amounts were obtained during follow-up questioning. As such, a final total of sixty-seven usable projects met the team's goal for detailed analysis.

Database

As the data were received, the project and cost data were compiled in a single list. Concurrently, the project and cost data along with the corresponding element scores were stored in a Microsoft Excel spreadsheet that was eventually converted to a Microsoft Access database. Several times throughout the data collection and analysis process the spreadsheet and database information were checked against the master list and against the individual questionnaires to ensure that no corruption of the data had taken place.

Data Reduction

Several steps were taken to verify the accuracy and reliability of the data. The questionnaire asked the respondents to identify whether or not significant factors affecting the difference between the base estimate and final costs (such as changes in scope or acts of God) had occurred. Any positive responses were followed up with a telephone call to ascertain the level of impact and whether or not any scope changes were discretionary. Discretionary scope changes were quantified wherever possible and the resulting actual costs were adjusted accordingly. If discretionary scope changes had occurred that could not be quantified, the project was eliminated from the data analysis.

Respondents who did not identify contingency or identified zero contingency were contacted by telephone to determine the true base estimate and true contingency values. Projects for which contingency (and thus the amount of the base estimate) could not be revealed or determined were eliminated from the analysis.

During the data analysis, the existence of "N/A", or "Not Applicable", responses to several of the elements from various respondents raised several concerns. The "Pre-Project Planning" research team had elected to give "N/A" responses a zero score without adjusting the final PDRI score relative to the fact that the "highest possible score" was reduced for that project. In essence, a score of "N/A" corresponded to a rating of better than one (or better than the best possible rating for that element). The "Improving Early Estimates" research team initially sought to overcome this problem by computing the final Estimate Score as the ratio of the total score divided by the highest possible score (with all "N/A" elements removed from the highest possible score). Although this process resolved part of the problem, it did not eliminate the difficulties associated with the "N/A" issue. The statistical methods required either an assignment of a value for each "N/A" element in each observation or elimination of those elements or those observations from the analysis. Whereas forty-nine of the projects contained "N/A" responses affecting thirty-four of the forty-five elements, the researchers deemed elimination of projects and/or elements on the basis of "N/A" responses both impractical and improper.

The option of assigning an arbitrary value to the "N/A" responses was also unappealing. Assigning appropriate "arbitrary" values cannot be achieved. The researchers asked the question, "Should every "N/A" response be given a rating of one (the best possible rating) or five (the worst) or three (a neutral rating)?" The correct value depends on the reason for a particular "N/A" response. For instance, if a respondent gave a rating of "N/A" to *bidding climate* because the construction was to be performed by an alliance contractor rather than being competitively bid, the correct rating would probably be a one (best). The estimator essentially had perfect information about the bidding climate because of the partnership with the contractor and sharing of cost information. By contrast, if *impact of contract type* were rated "N/A" because no contract type had yet been chosen, a rating of five (worst) would be appropriate because the lack of information available about the contracting strategy means that its impact was not considered in the estimate.

Another problem arose from the use of "Yes/No" responses on the PDRI questionnaire. The "Pre-Project Planning" research team had identified several elements as requiring a polarized "Yes/No" response. These elements included *project schedule* and *site location*. The "Pre-Project Planning" research team had concluded that either a project schedule exists or it does not and either the site location is known or it is not. However, the "Improving Early Estimates" research team concluded that degrees of definition and degrees of certainty can exist for a project schedule and for the site location. In addition, the preliminary data analysis identified that forcing the respondents to provide a polarized "Yes/No" rating caused those elements to exert undue influence in the statistical analyses.

To correct these problems each of the initial respondents and each of the secondary respondents who identified "N/A" elements were contacted to determine the appropriate one-to-five rating for each of the "N/A" and "Yes/No" elements in question.

Limitations of the Data

The research team acknowledged at the start of this research effort that a distinct limitation would be inherent in the data collection process. This limitation was due to the fact that collecting Estimate Score data on completed projects would require the respondents to recall a project in order to rate the scope definition and score the estimate at the time the estimate was prepared. Because of the lengthy durations of process industry capital projects, respondents were often required to recall projects from several years ago when filling out the questionnaire. As such, the data have limitations corresponding to the memory, knowledge, experience and abilities of the individual respondents.

Another limitation in the data is that some minor changes were made to Division 4 of the questionnaire between the initial and final phases of the data collection process. As mentioned previously, four of the Division 4 elements were combined into two elements. When *logistics for engineering* and *logistics for construction* were combined into *logistics for engineering and construction*, an average of the two element ratings was used for those projects collected initially. When *domestic governmental requirements* and *foreign governmental requirements* were combined into *governmental* *requirements* almost all of the respondents had rated "N/A" for one of the two elements. As such, the non-"N/A" element rating was used.

Demographics of the Projects

Sixty-seven usable projects were collected from twenty-two companies consisting of sixteen owners and six contractors and engineering firms. Figures 4 and 5 give a breakdown of the projects by project sub-type and classification respectively. Figure 6 shows the distribution of projects by total installed cost (TIC). The TIC of the projects totaled $5.6 billion. The project cost and Estimate Score information for the sixty-seven projects are presented in Appendix B.

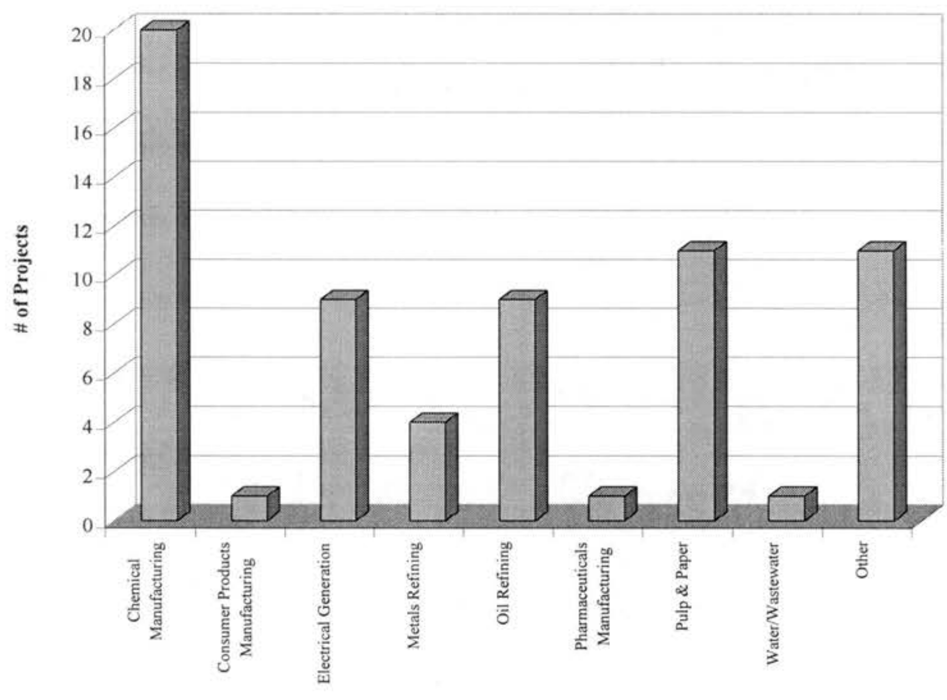


Figure 4 – Distribution of Projects by Sub-Type

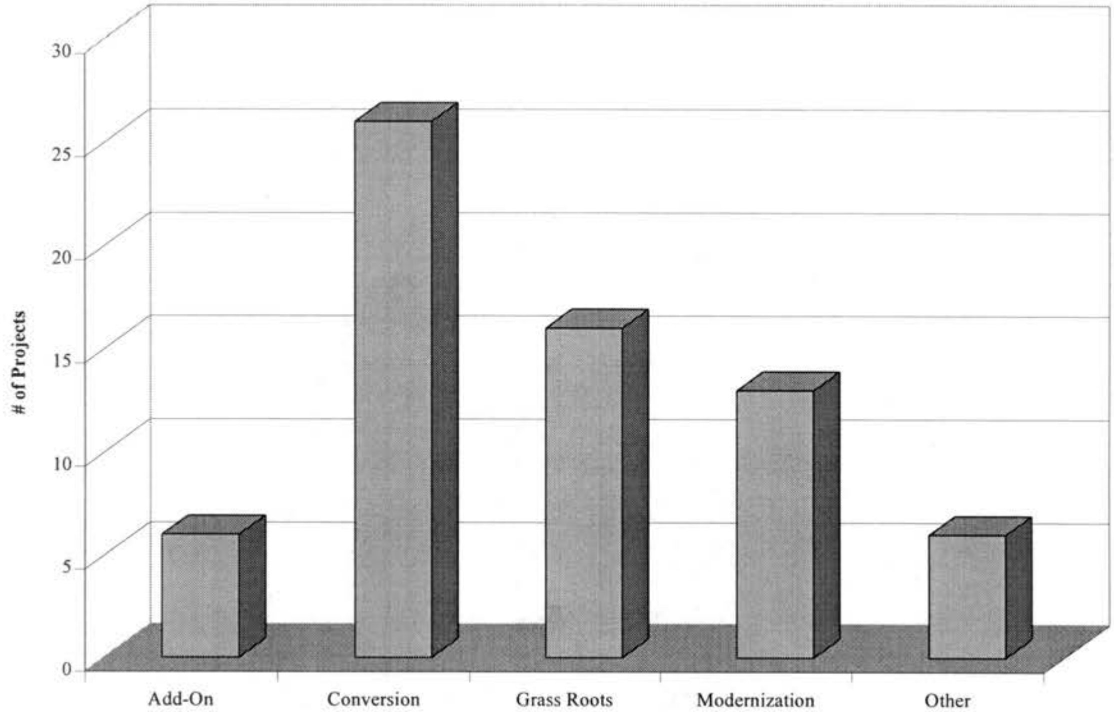


Figure 5 – Distribution of Projects by Classification

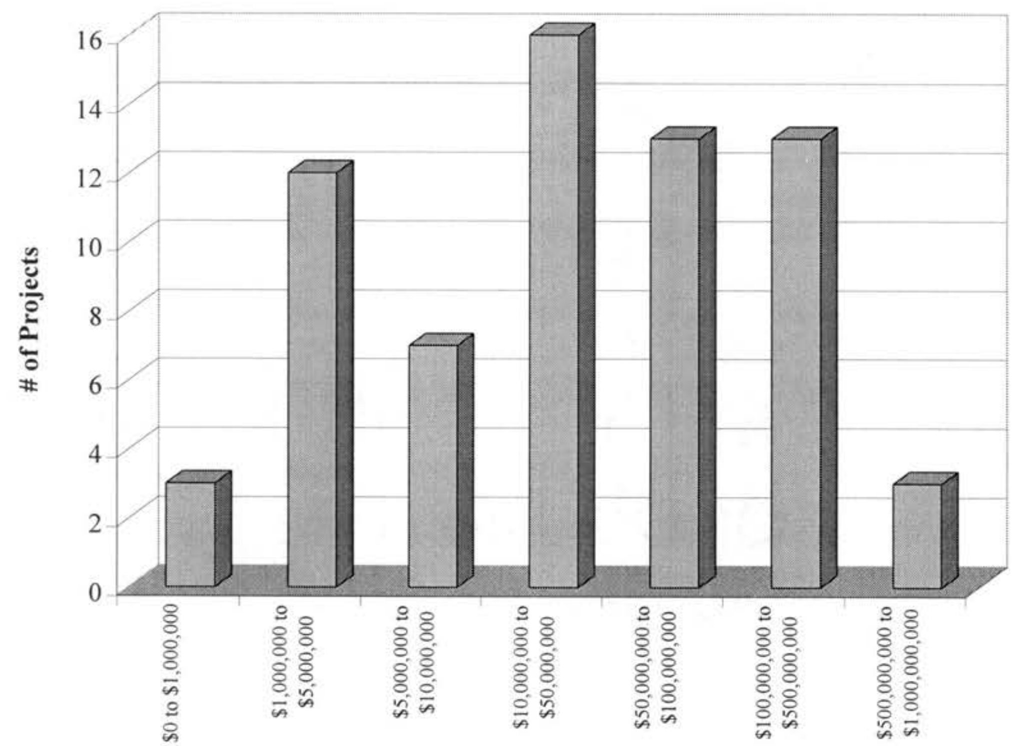


Figure 6 – Distribution of Projects by Total Installed Cost (TIC)

CHAPTER IV

DATA ANALYSIS METHODOLOGY

Subjective Analysis (Analytical Hierarchy Process)

The research team, which was comprised of estimating professionals from numerous Fortune 500 corporations, recognized that differences often exist between the subjective opinions of "experts" and the results of statistical analyses of actual data. The recognition of this fact led the research team to question themselves about the content of their own subjective opinions. In essence, the question was asked, "If we, as a team, had to rank and weight each of the elements from the Estimate Score sheet, what would those rankings and weights be?"

To accomplish this task, each of the team members was asked to rate the importance of each element from zero to one hundred as it relates to estimate accuracy. Whereas the individual elements had been chosen based on their perceived impact on estimate accuracy, the responses from this exercise yielded little differentiation among the various elements. To overcome the lack of differentiation problem, a technique known as the analytical hierarchy process was employed.

The Analytical Hierarchy Process (AHP) was developed by Thomas Saaty in the 1970s and has become a common tool in multi-criteria decision-making. Multi-criteria decision-making involves choosing among (or developing a ranking for) several different alternatives. AHP involves pairwise comparisons of each of the important characteristics of each of the alternatives. AHP utilizes pairwise comparisons to transform the decision-making process from a single selection among many alternatives to multiple selections between only two alternatives at a time. One disadvantage of AHP lies in the fact that for n alternatives, $n*(n-1)/2$ separate comparisons must be made.

The "Improving Early Estimates" research team utilized AHP to create a subjective ranking of the various elements of the Estimate Score. Because the Estimate Score contains 45 elements, a complete AHP analysis would have required 0.5*(45)*(44) = 990 separate pairwise comparisons. This difficulty was overcome by performing pairwise comparisons within each of the four divisions and then comparing each of the four divisions themselves in a pairwise fashion. The resulting AHP comparisons required 6+36+91+55+55 = 243 individual comparisons. The results of the AHP analysis are presented in Chapter V.

Regression Analysis

Multivariate regression was performed on the forty-five elements based on the sixty-seven observations. The analysis, as expected, produced varying results depending upon which of the forty-five elements were included in the analysis as well as the order in which they were added or removed during the analysis. Whereas all of the elements related, in one way or another, to the issue of estimate accuracy and whereas many of the elements were related to each other, multicollinearity was an undeniable problem.

Factor Analysis

The researchers sought to overcome the multicollinearity problem by performing a factor analysis on the data. Factor analysis provided a deterministic method to group the elements into meaningful subdivisions. Factor rotations were performed based on both the varimax and maximum-likelihood methods. Both methods yielded similar results; but the varimax method was chosen for the final analysis because the maximum-likelihood method requires iterations that do not always converge whereas the varimax method does not require iterative calculations. One important decision in the factor analysis dealt with the determination of the number of factors to include in the development of the prediction model.

Several guidelines are available to assist statisticians in determining how many factors to include in a factor analysis. One of the most common guidelines is known as the minimum eigenvalue criterion. Essentially, this method involves taking the principle components of all the variables, ranking their eigenvalues from greatest to least, then selecting the number of eigenvalues greater than one as the criteria for the number of factors to include in the factor analysis. The minimum eigenvalue method recommended thirteen factors based on the forty-five variables and sixty-seven observations.

Another important consideration in deciding the number of factors centers on the interpretability and meaningfulness of the resultant groups. In this sense, factor analysis can become as much an art as a science. The researchers utilized the minimum eigenvalue criterion as a starting point to determine the proper number of factors. Figure 7 gives a pictorial representation of the factor groups and how the various elements stay together or separate as the number of factors changes. The figure is color-coded such that the thirteen factor groups recommended by the minimum eigenvalue criterion can be identified throughout. The number at the top of each column signifies the number of factors included. Several interesting changes can be observed from Figure 7 as the number of factors is reduced from thirteen to eleven. The elements in the first factor (3.8, 3.10, 3.14, 3.9, 3.1 and 3.11) all stay together but move to the second factor. Similarly, the elements in the third factor (2.4, 2.7, 2.9, 2.10, 2.8 and 2.6) also stay together, but elements 1.8, 1.4 and 4.2 join them.

Based on this analysis, eleven factors were chosen for the final analysis. Table 3 shows the rotated factor-loading matrix for the eleven-factor analysis. The factor groups and their practical implications are described in Chapter V. An eleven-factor model was chosen because the resultant groups made the most theoretical and practical sense. Table 4 identifies the amount of variance explained by each of the eleven factors. Figure 8 provides the same information as Figure 7 except that the color-coding has been changed to facilitate identification of the elements that make up the eleven factor groups.

The factor analysis and subsequent regression analysis were performed using The SAS System for Windows version 6.12. The SAS program and output for the analyses can be found in Appendix C and Appendix D respectively.

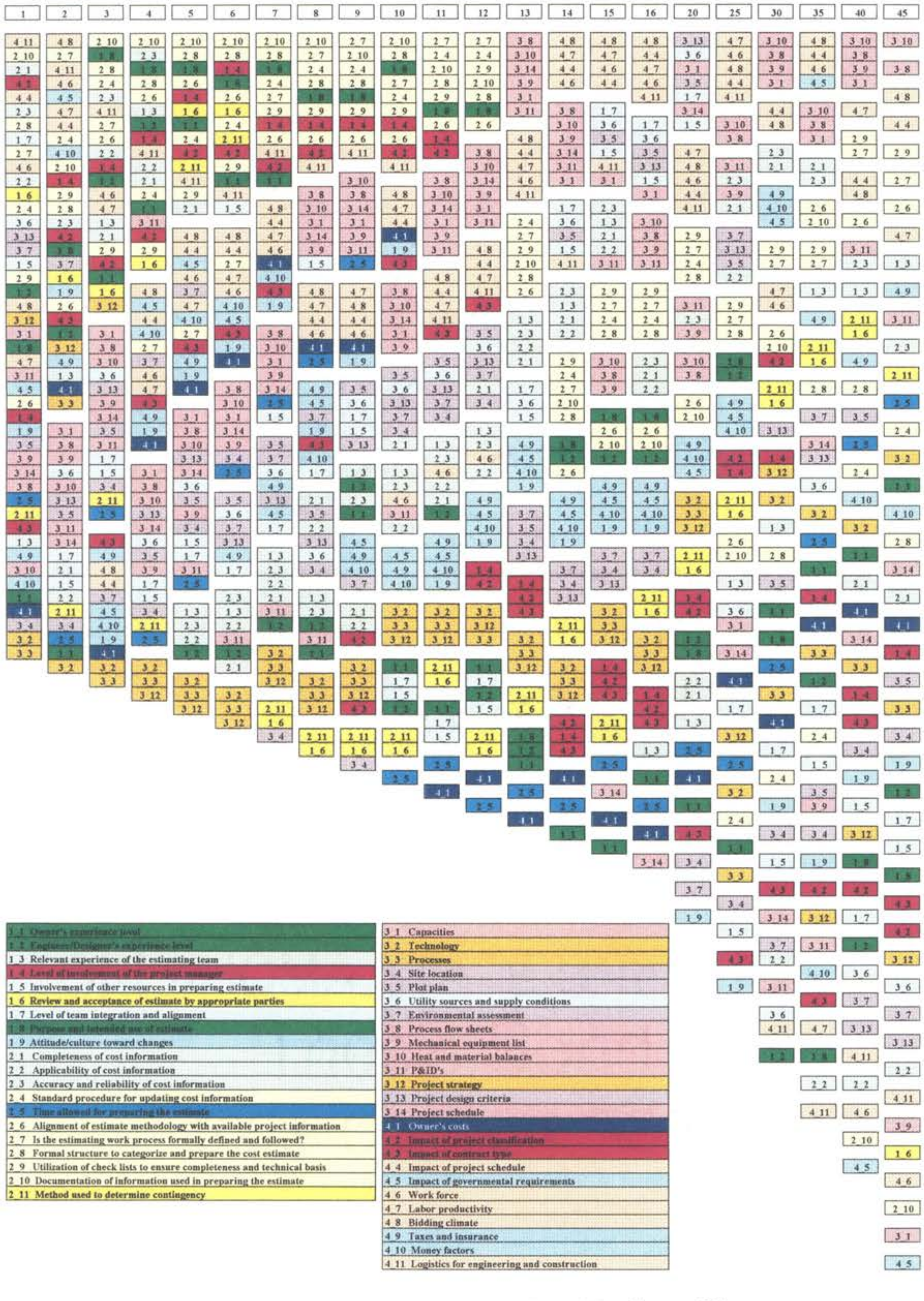


Figure 7 – Factor Groups for Various Numbers of Factors Based on the Minimum Eigenvalue Criterion

Table 3 – Rotated Factor-Loading Matrix for Eleven Factors

Element #	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Factor 11
2.7	0.72	(0.01)	0.52	(0.02)	(0.01)	0.07	(0.03)	(0.01)	(0.01)	0.07	0.27
2.4	0.70	(0.02)	0.19	0.02	0.11	0.18	0.10	(0.07)	0.13	0.23	0.10
2.10	0.69	0.11	0.22	0.31	0.23	(0.10)	(0.14)	0.24	0.10	0.01	(0.10)
2.8	0.68	0.20	0.09	0.07	0.22	0.11	(0.00)	0.23	0.06	0.02	(0.07)
2.9	0.66	0.17	0.19	0.12	0.06	0.20	0.06	(0.05)	0.07	(0.08)	0.07
1.8	0.63	0.08	0.06	0.02	0.27	0.10	0.13	0.04	0.19	(0.00)	(0.25)
2.6	0.50	(0.14)	0.15	0.28	0.19	(0.28)	(0.13)	0.23	0.23	0.17	0.13
1.4	0.47	(0.01)	0.19	(0.13)	0.17	0.26	(0.25)	0.37	0.05	0.23	(0.25)
4.2	0.45	0.14	0.10	0.32	0.16	0.13	(0.21)	0.24	0.10	0.40	0.11
3.8	0.09	0.78	(0.02)	0.20	0.24	(0.19)	(0.13)	0.02	0.05	0.02	0.12
3.10	0.08	0.76	(0.04)	0.08	0.01	0.02	0.04	0.16	0.05	0.03	0.08
3.14	(0.05)	0.67	0.30	0.21	(0.02)	0.19	0.03	0.13	(0.08)	0.06	0.05
3.1	0.23	0.61	(0.03)	0.35	0.07	(0.07)	0.24	(0.01)	0.11	0.34	0.14
3.9	0.38	0.59	(0.26)	0.27	0.11	(0.00)	0.06	(0.03)	(0.02)	0.24	(0.24)
3.11	0.06	0.51	0.06	0.09	0.47	0.04	(0.11)	0.25	0.17	0.19	(0.30)
4.8	0.28	(0.08)	0.84	(0.01)	0.04	0.19	0.04	0.10	0.07	0.13	0.01
4.4	0.24	0.31	0.73	0.06	0.16	0.20	(0.09)	(0.05)	0.02	0.13	0.06
4.7	0.20	(0.12)	0.67	0.09	0.40	0.03	0.11	0.06	0.03	0.00	0.18
4.11	0.30	0.02	0.49	0.28	0.26	0.17	(0.17)	0.13	0.39	0.11	(0.17)
4.3	0.16	0.11	0.40	0.28	(0.09)	0.35	(0.41)	(0.08)	(0.10)	0.06	0.09
3.5	0.18	0.26	0.01	0.82	(0.04)	0.12	(0.10)	(0.05)	0.06	(0.07)	(0.15)
3.6	0.05	0.32	0.08	0.64	0.23	0.15	0.26	0.06	0.34	0.02	0.04
3.13	0.06	0.30	0.17	0.60	0.00	0.13	0.19	0.24	0.15	0.24	0.12
3.7	0.16	0.12	0.27	0.51	0.07	0.50	0.15	0.07	(0.15)	0.19	0.12
3.4	(0.15)	0.24	(0.12)	0.42	0.15	0.05	(0.03)	0.31	(0.30)	(0.04)	0.19
1.3	0.17	0.12	0.13	(0.10)	0.78	(0.04)	0.02	(0.03)	0.11	(0.12)	0.10
2.3	0.30	0.17	0.17	0.15	0.68	0.05	(0.18)	0.04	0.10	0.25	(0.09)
4.6	0.17	(0.05)	0.54	0.17	0.57	0.23	0.10	0.15	(0.09)	0.06	0.08
2.2	0.30	0.03	0.06	0.38	0.53	(0.00)	0.26	(0.08)	0.18	0.38	0.05
2.1	0.34	0.10	0.05	0.43	0.45	0.10	(0.10)	0.22	(0.03)	0.44	0.01
1.2	0.35	0.36	0.11	(0.03)	0.44	0.20	0.10	(0.04)	0.42	(0.21)	0.03
4.9	0.11	0.05	0.10	0.21	(0.07)	0.75	(0.15)	0.11	0.06	(0.05)	0.11
4.5	0.20	(0.15)	0.38	0.06	0.14	0.65	0.04	0.02	0.28	0.22	(0.20)
4.10	0.22	(0.30)	0.28	(0.01)	0.20	0.53	0.11	0.32	(0.08)	(0.08)	0.16
1.9	0.23	0.22	0.26	0.18	0.14	0.43	(0.11)	(0.28)	0.09	0.01	0.25
3.2	0.02	0.06	(0.06)	(0.02)	0.06	0.11	0.84	(0.08)	0.03	0.16	(0.01)
3.3	0.03	(0.05)	0.13	0.17	(0.10)	(0.35)	0.69	0.08	(0.04)	(0.16)	(0.13)
3.12	0.37	0.31	0.35	0.11	(0.15)	0.17	0.42	0.20	0.05	0.20	(0.18)
2.11	0.11	0.23	0.00	0.14	(0.00)	0.11	(0.04)	0.80	0.21	(0.02)	0.05
1.6	0.40	0.26	0.28	0.07	0.06	(0.02)	0.14	0.59	0.08	0.02	0.23
1.1	0.19	(0.06)	(0.13)	0.01	0.19	(0.00)	0.12	0.29	0.68	0.12	(0.01)
1.7	0.20	0.28	0.25	0.40	0.04	0.08	(0.15)	0.01	0.58	0.13	0.02
1.5	0.30	0.32	0.12	0.31	0.06	0.12	(0.08)	0.12	0.41	(0.10)	0.36
2.5	0.06	0.28	0.26	0.01	0.02	0.02	0.11	(0.05)	0.10	0.71	0.14
4.1	(0.03)	0.16	0.19	0.00	0.07	0.20	(0.16)	0.17	0.00	0.23	0.70

Table 4 – Variance Explained by the Eleven Factors

Factor #	Variance Explained	% Variance Explained	Cumulative % Variance Explained
1	5.13	11.4%	11.4%
2	4.06	9.0%	20.4%
3	3.92	8.7%	29.1%
4	3.44	7.6%	36.8%
5	3.15	7.0%	43.8%
6	2.67	5.9%	49.7%
7	2.25	5.0%	54.7%
8	2.13	4.7%	59.4%
9	2.00	4.4%	63.9%
10	1.88	4.2%	68.1%
11	1.53	3.4%	71.5%

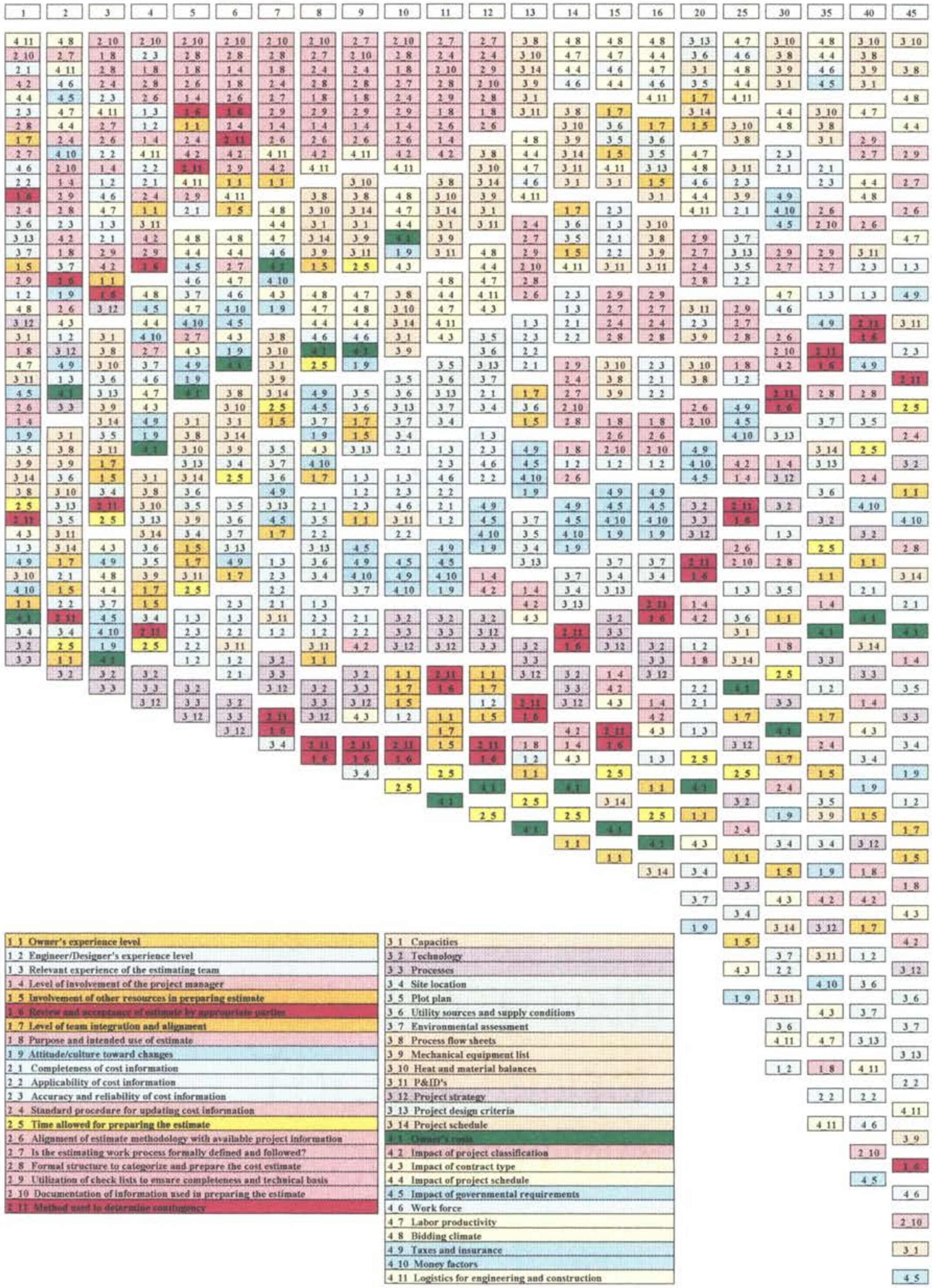


Figure 8 – Factor Groups for Various Numbers of Factors Based on Eleven Factors

Regression Analysis on the Factors

Once the elements had been adequately grouped into meaningful factors, a stepwise multivariate regression analysis was performed on the factor scores derived from the eleven factors. The very nature of factor analysis creates orthogonal factors. Therefore, multicollinearity was no longer an issue. Figures 9 through 14 demonstrate the effect of multicollinearity on parameter estimates during a stepwise regression analysis. Figures 9 through 13 show how the parameter estimates for each of the variables change as additional elements are added to the analysis. By contrast, Figure 14 demonstrates the fact that the orthogonal factors can be added or removed from the analysis without affecting the parameter estimates of the remaining factors.

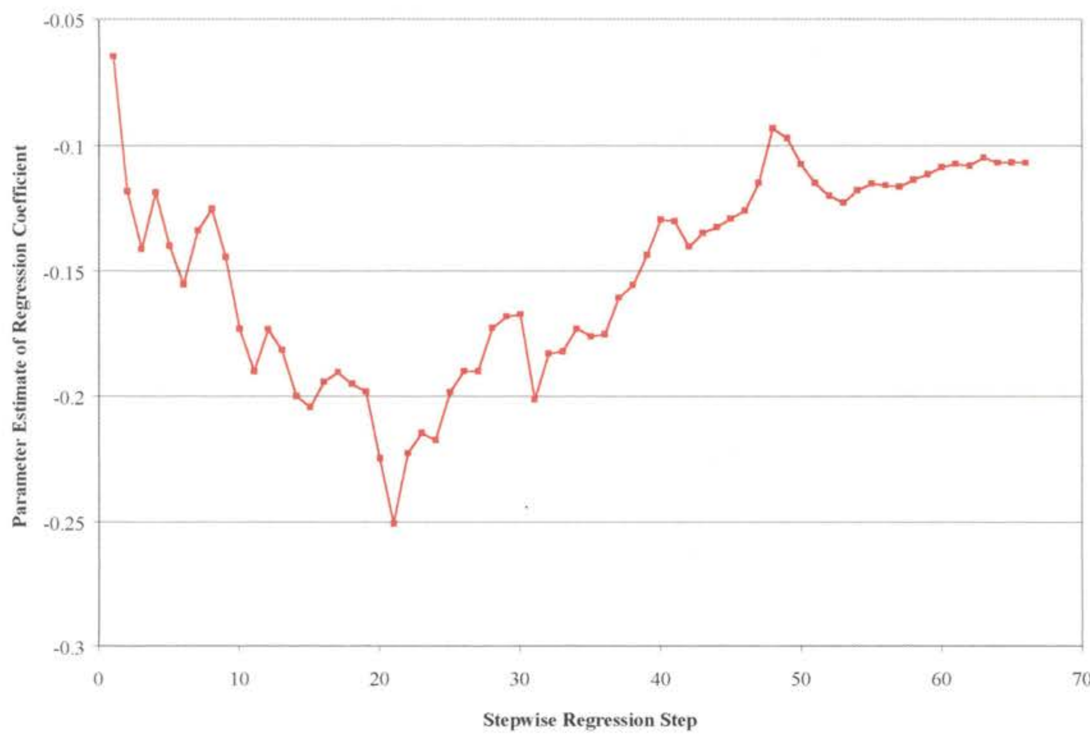


Figure 9 – Parameter Estimates with Multicollinearity (Intercept)

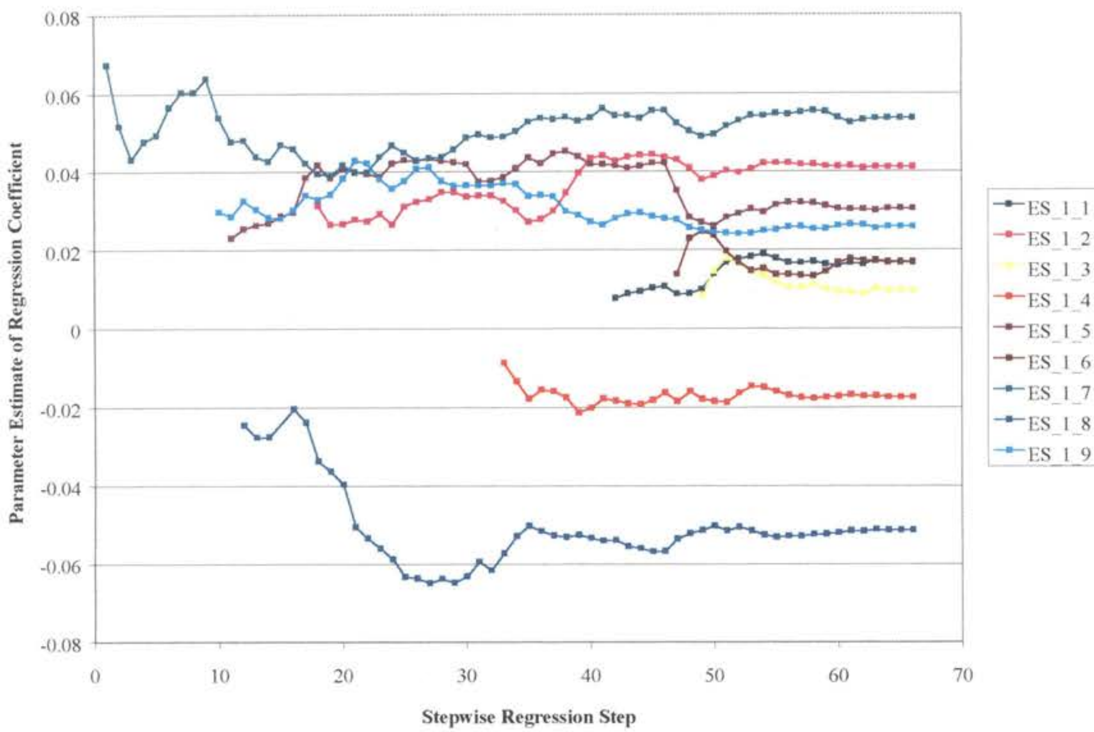


Figure 10 – Parameter Estimates with Multicollinearity (Division 1)

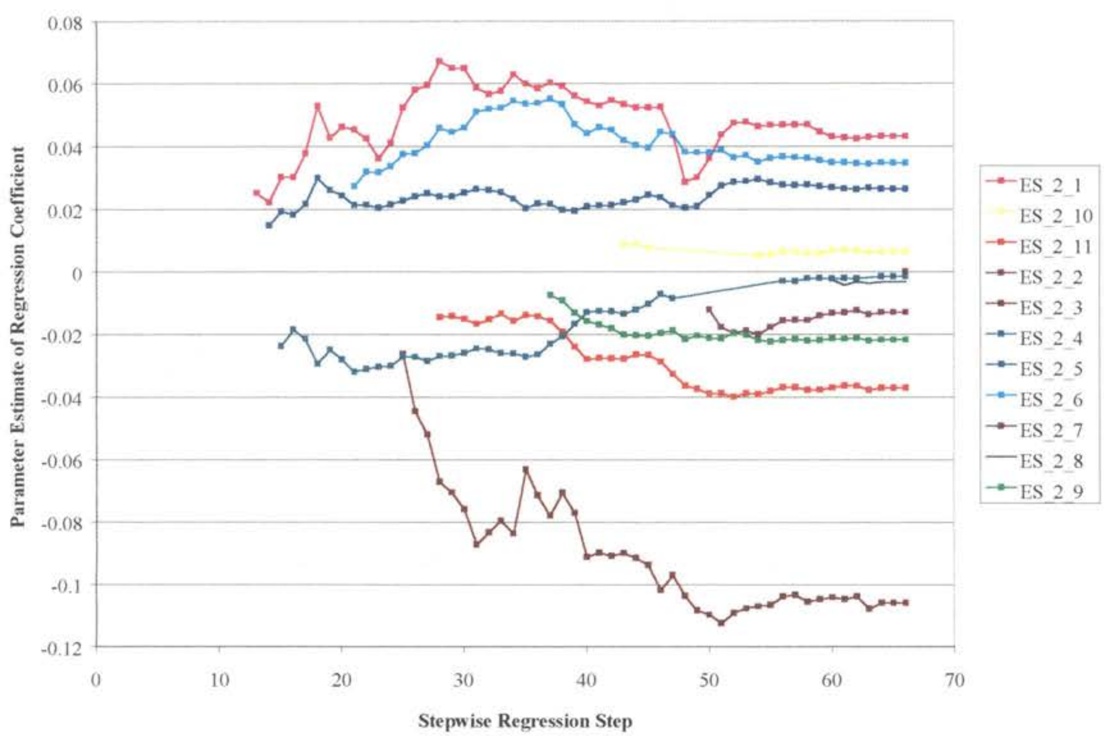


Figure 11 – Parameter Estimates with Multicollinearity (Division 2)

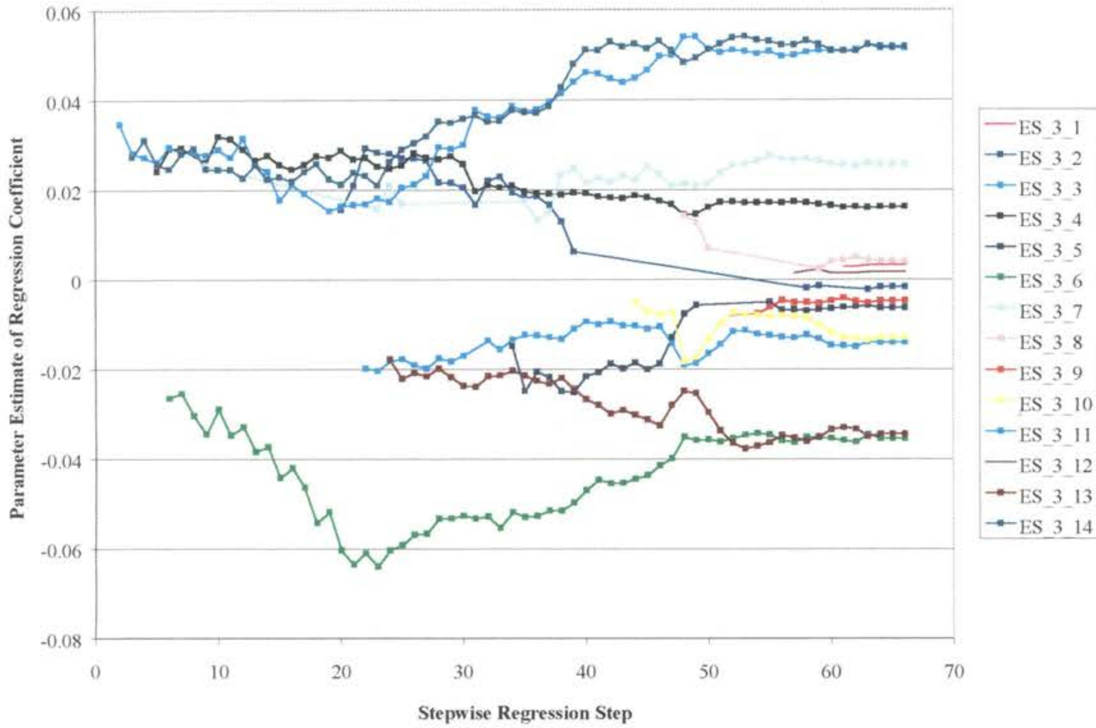


Figure 12 – Parameter Estimates with Multicollinearity (Division 3)

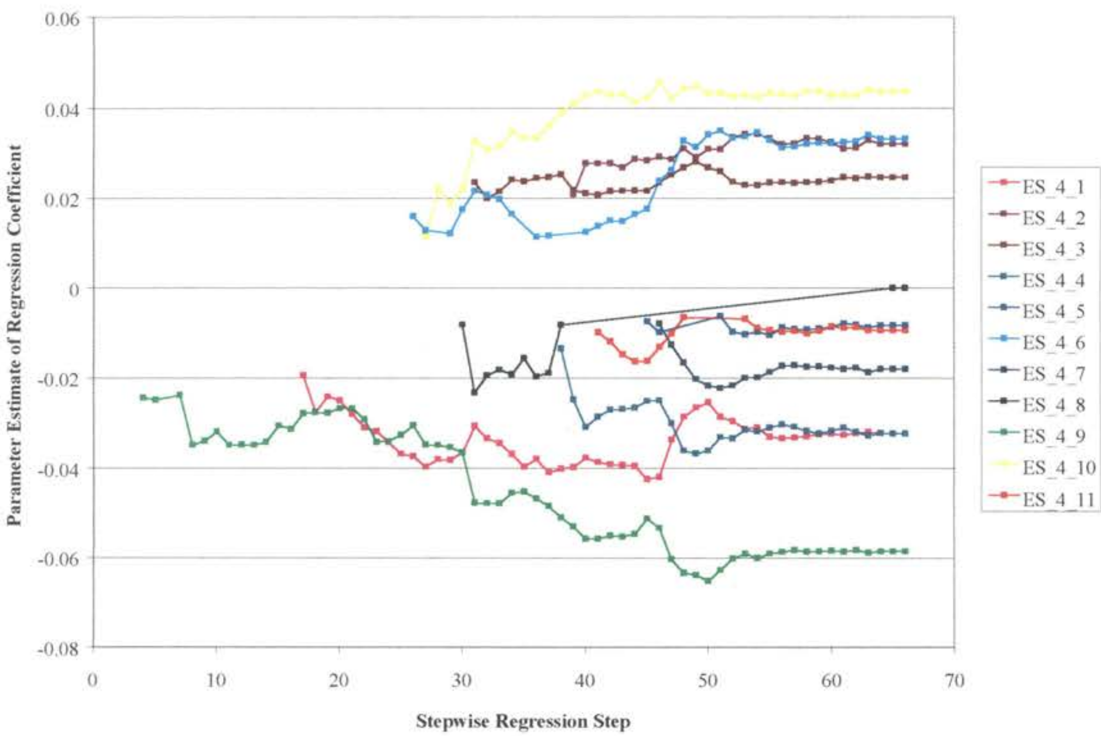


Figure 13 – Parameter Estimates with Multicollinearity (Division 4)

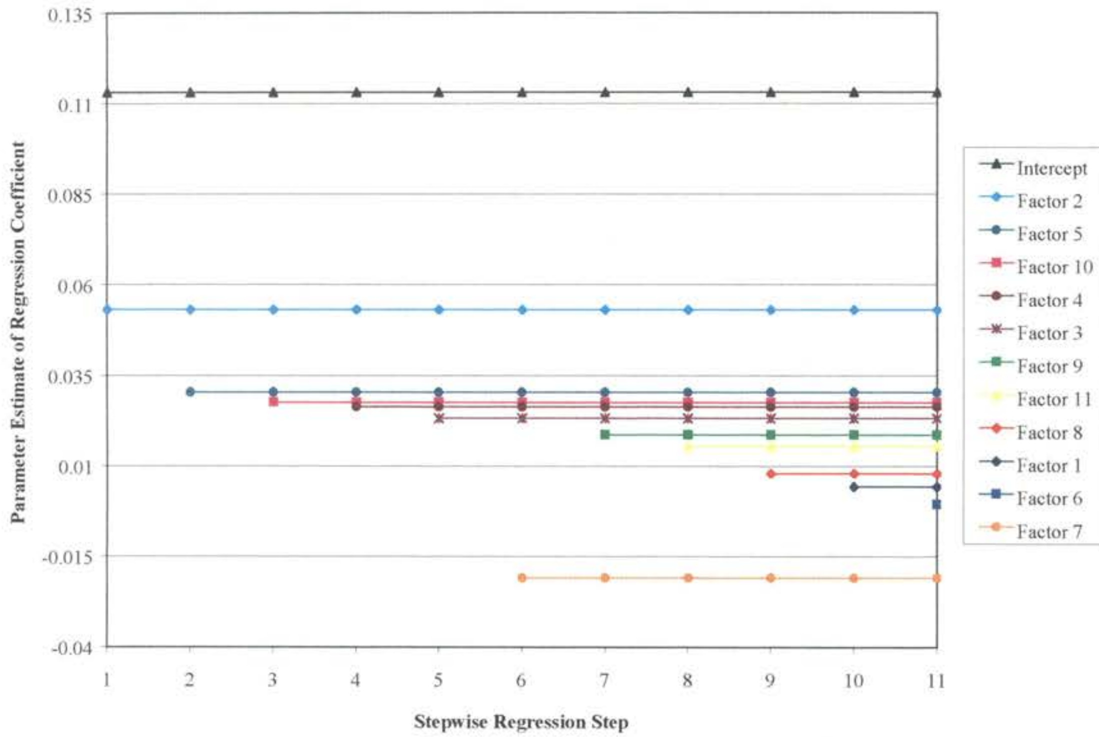


Figure 14 – Parameter Estimates with Orthogonal Factors

CHAPTER V

DATA ANALYSIS RESULTS

The "Subjective" Model

Chapter IV described the Analytical Hierarchy Process (AHP) that was utilized to develop a subjective model based on the opinions of the research team members. The results of the AHP analysis are given in Table 5.

Factor Groups

The rotated factor-loading matrix shown in Chapter IV (Table 3) was used to establish the factor groups. The final factor groups are shown in Table 6. The names given to the various factors are based on the perceived relationships among the primary elements in each factor.

Table 5 – Element Score Values for the "Subjective" Model (AHP)

Element #	Element Rating & Score				
	1	2	3	4	5
1.1	0.0	0.4	0.8	1.2	1.6
1.2	0.1	1.0	1.9	2.9	3.8
1.3	0.1	1.9	3.9	5.8	7.8
1.4	0.0	0.5	1.0	1.5	2.0
1.5	0.0	0.4	0.8	1.2	1.6
1.6	0.1	1.1	2.2	3.3	4.4
1.7	0.0	0.8	1.7	2.5	3.4
1.8	0.0	0.2	0.3	0.5	0.6
1.9	0.0	0.8	1.5	2.3	3.0
2.1	0.0	0.6	1.1	1.7	2.3
2.2	0.1	1.6	3.1	4.7	6.2
2.3	0.0	0.8	1.5	2.3	3.0
2.4	0.0	0.1	0.2	0.2	0.3
2.5	0.0	0.3	0.6	0.9	1.2
2.6	0.0	0.3	0.6	0.9	1.1
2.7	0.0	0.1	0.2	0.3	0.4
2.8	0.0	0.2	0.3	0.5	0.6
2.9	0.0	0.1	0.3	0.4	0.5
2.10	0.0	0.1	0.2	0.3	0.4
2.11	0.0	0.3	0.6	0.9	1.2
3.1	0.1	1.8	3.6	5.4	7.2
3.2	0.1	1.2	2.5	3.7	4.9
3.3	0.1	0.9	1.8	2.8	3.7
3.4	0.1	0.9	1.9	2.8	3.8
3.5	0.0	0.4	0.8	1.2	1.6
3.6	0.0	0.5	1.0	1.5	2.0
3.7	0.0	0.8	1.5	2.3	3.1
3.8	0.0	0.8	1.6	2.4	3.2
3.9	0.1	1.1	2.3	3.4	4.5
3.10	0.0	0.5	1.1	1.6	2.1
3.11	0.1	1.0	2.1	3.1	4.2
3.12	0.0	0.7	1.5	2.2	2.9
3.13	0.0	0.7	1.4	2.1	2.7
3.14	0.0	0.8	1.5	2.3	3.1
4.1	0.0	0.0	0.1	0.1	0.2
4.2	0.0	0.2	0.5	0.7	1.0
4.3	0.0	0.1	0.2	0.2	0.3
4.4	0.0	0.2	0.3	0.5	0.7
4.5	0.0	0.1	0.2	0.3	0.4
4.6	0.0	0.2	0.3	0.5	0.7
4.7	0.0	0.2	0.4	0.6	0.8
4.8	0.0	0.2	0.3	0.5	0.6
4.9	0.0	0.0	0.1	0.1	0.2
4.10	0.0	0.0	0.1	0.1	0.2
4.11	0.0	0.1	0.2	0.4	0.5

Table 6 – Eleven Factor Groups

Factor 1		**Formal estimating process**
	2.7	Is the estimating work process formally defined and followed?
	2.4	Standard procedure for updating cost information
	2.10	Documentation of information used in preparing the estimate
	2.8	Formal structure to categorize and prepare the cost estimate
	2.9	Utilization of check lists to ensure completeness and technical basis
	1.8	Purpose and intended use of estimate
	2.6	Alignment of estimate methodology with available project information
	1.4	Level of involvement of the project manager
	4.2	Impact of project classification
Factor 2		**Basic process design**
	3.8	Process flow sheets
	3.10	Heat and material balances
	3.14	Project schedule
	3.1	Capacities
	3.9	Mechanical equipment list
	3.11	Piping & Instrumentation Diagrams (P&IDs)
Factor 3		**Bidding and labor climate**
	4.8	Bidding climate
	4.4	Impact of project schedule
	4.7	Labor productivity
	4.11	Logistics for engineering and construction
	4.3	Impact of contract type
Factor 4		**Site requirements**
	3.5	Plot plan
	3.6	Utility sources and supply conditions
	3.13	Project design criteria
	3.7	Environmental assessment
	3.4	Site location
Factor 5		**Team experience and cost information**
	1.3	Relevant experience of the estimating team
	2.3	Accuracy and reliability of cost information
	4.6	Work force
	2.2	Applicability of cost information
	2.1	Completeness of cost information
	1.2	Engineer/Designer's experience level
Factor 6		**Money issues**
	4.9	Taxes and insurance
	4.5	Impact of governmental requirements
	4.10	Money factors
	1.9	Attitude/culture toward changes
Factor 7		**Technology issues**
	3.2	Technology
	3.3	Processes
	3.12	Project strategy
Factor 8		**Contingency and reviews**
	2.11	Method used to determine contingency
	1.6	Review and acceptance of estimate by appropriate parties
Factor 9		**Team alignment**
	1.1	Owner's experience level
	1.7	Level of team integration and alignment
	1.5	Involvement of other resources in preparing estimate
Factor 10		**Time allowed to prepare the estimate**
	2.5	Time allowed for preparing the estimate
Factor 11		**Owner's costs**
	4.1	Owner's costs

Regression Analysis of the Factor Groups

Table 7 gives the results of the regression analysis of the eleven factors. As can be seen, the parameter estimates of the regression coefficients for four of the factors (2, 4, 5 and 10) were significant at the $\alpha = 5\%$ level and five (2, 3, 4, 5 and 10) were significant at the $\alpha = 10\%$ level. The parameter estimates for Factors 6 and 7 were negative and therefore somewhat troubling. These negative parameter estimates are further discussed in Chapter V. The estimated standard error values are essentially equal for all regression variables because the variables have been normalized and are orthogonal.

Table 7 – Regression Results on the Eleven Factors

Factor #	Parameter Estimate	Standard Error	F	P-value
Intercept	0.1132	0.0128	77.56	0.0001
2	0.0531	0.0129	16.83	0.0001
5	0.0303	0.0129	5.49	0.0228
10	0.0276	0.0129	4.53	0.0378
4	0.0263	0.0129	4.13	0.0469
3	0.0232	0.0129	3.23	0.0780
7	-0.0209	0.0129	2.61	0.1119
9	0.0186	0.0129	2.07	0.1563
11	0.0155	0.0129	1.43	0.2368
8	0.0080	0.0129	0.38	0.5397
1	0.0044	0.0129	0.12	0.7345
6	-0.0006	0.0129	0.00	0.9619

The "Pure" Models

The models presented in this section are referred to as "pure" models because they are based on the complete factor scores of the eleven factors rather than the abbreviated factor scores used in the Estimate Score model. The Estimate Score model will be discussed later.

The stepwise regression analysis on the complete factor scores of the eleven factors produced an interesting prediction model. The question posed by the researchers was, "Do the regression results present an *adequate* model for predicting estimate accuracy?" Hypothesis testing was utilized to make that determination. The first question to be asked was, "Do we have an adequate model based on all eleven factors?" To answer this question, a hypothesis was formulated and tested as follows:

Choose $\alpha = 10\%$.

$$y_t = \beta_1 + \beta_2 \cdot F_1 + \beta_3 \cdot F_2 + \cdots + \beta_{12} \cdot F_{11} + e_t \qquad \text{Equation 5.1}$$

H_0: $\beta_2 = \beta_3 = \cdots \beta_{12} = 0$ (no model)

H_A: $\beta_2 \neq 0$ and/or $\beta_3 \neq 0$ and/or $\cdots \beta_{12} \neq 0$ (model exists)

An F-test was used to test this hypothesis based on the following assumption:

$$F = \frac{(SSE_R - SSE_U)/(12-1)}{SSE_U/(67-12)} \sim F_{11,55}$$

where SSE_R = Sum of Squared Errors for the restricted model (Equation 5.2)

$$y_t = \beta_1 + e_t \qquad \text{Equation 5.2}$$

and SSE_U = Sum of Squared Errors for the unrestricted model (Equation 5.1).

Whereas $SSE_R = 1.0597$ and $SSE_U = 0.6083$, then $F = 3.71$ which is greater than $F_{11,55\ (\alpha=10\%)} = 1.69$. Therefore, reject H_0 and conclude that Equation 5.1 is an adequate model ($p < 0.001$, $R^2 = 0.4260$, $MSE = 0.01106$).

Figure 14 demonstrated the perfect orthogonality of the eleven factors. Orthogonality means that one or more of the variables can be removed from the analysis without changing the parameter estimates or predicted standard errors of the remaining variables. In light of this fact, the researchers decided to remove from the model the six factors that were not significant at the $\alpha = 10\%$ level. This left Factors 2, 3, 4, 5 and 10. Equation 5.3 shows the resulting model.

$$y_t = \beta_1 + \beta_2 \cdot F_2 + \beta_3 \cdot F_3 + \beta_4 \cdot F_4 + \beta_5 \cdot F_5 + \beta_6 \cdot F_{10} + e_t \qquad \text{Equation 5.3}$$

Once again, an F-test was performed to determine the significance of the model. Again, the assumption was as follows:

$$F = \frac{(SSE_R - SSE_U)/(6-1)}{SSE_U/(67-6)} \sim F_{5,61}$$

where SSE_R = Sum of Squared Errors for the restricted model (Equation 5.2) and SSE_U = Sum of Squared Errors for the unrestricted model (Equation 5.3).

Whereas $SSE_R = 1.0597$ and $SSE_U = 0.68138$, then $F = 6.77$ which is greater than $F_{5,61\ (\alpha=10\%)} = 1.94$. Therefore, reject H_0 and conclude that Equation 5.3 is an adequate model ($p < 0.0001$, $R^2 = 0.3570$, $MSE = 0.01117$).

Cross-Validation by Bootstrapping

A statistical technique known as bootstrapping was utilized as a cross-validation tool. Bootstrapping involves taking a sample with *n* observations and then creating many separate samples, each with *n* observations. Each of the new samples is created by randomly selecting *n* observations from the original sample *with replacement*. Thus, for any one of the new samples, a given observation from the original sample may occur multiple times or not at all. The desired statistic is then calculated for each of the new samples and the resulting values are plotted as a cumulative probability curve. The shape of the curve can give insight into whether or not one or more of the observations are causing undue influence in the model as well as provide valuable information concerning confidence intervals for the statistics of the model. Figure 15 depicts the results of bootstrapping performed on Equations 5.1 and 5.3 for the R^2 statistic and Figure 16 gives the results for the Mean Square Error (MSE). These figures also show the bootstrapping results of the "practical" model discussed below and the "subjective" model described previously. Bootstrapping provides a means for placing confidence limits on the various statistics being analyzed. For instance, an eighty-percent confidence limit on the MSE for Equation 5.3 would be [0.0079,0.0127], as shown in Figure 16.

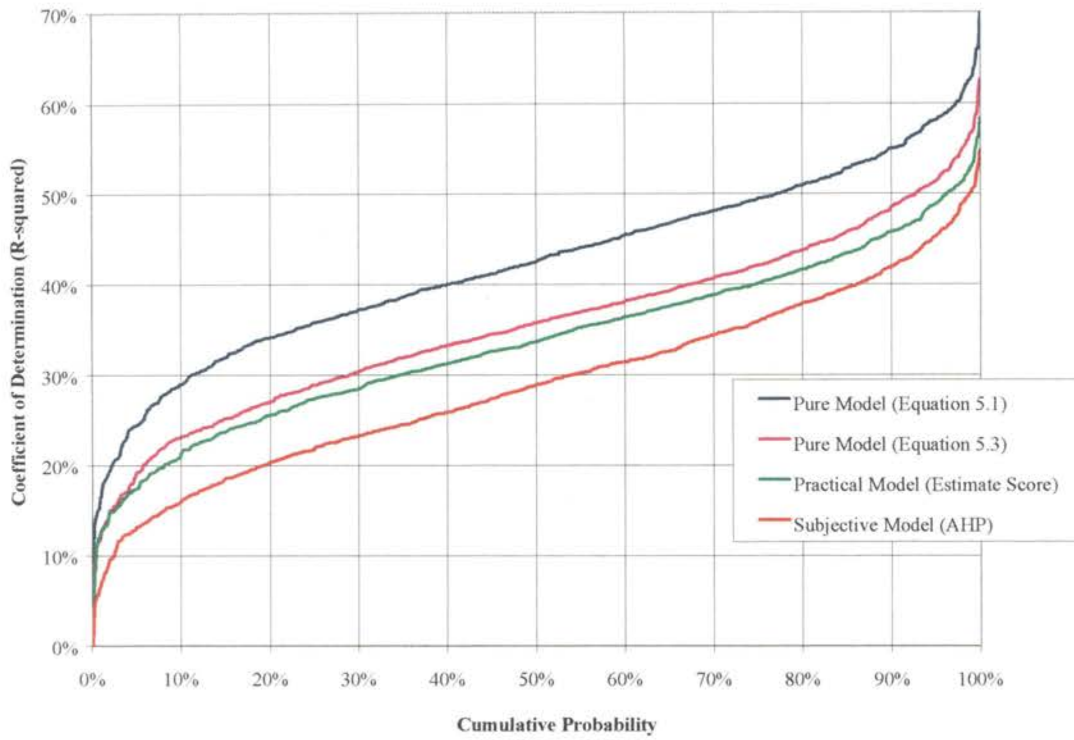


Figure 15 – Bootstrapping on R^2

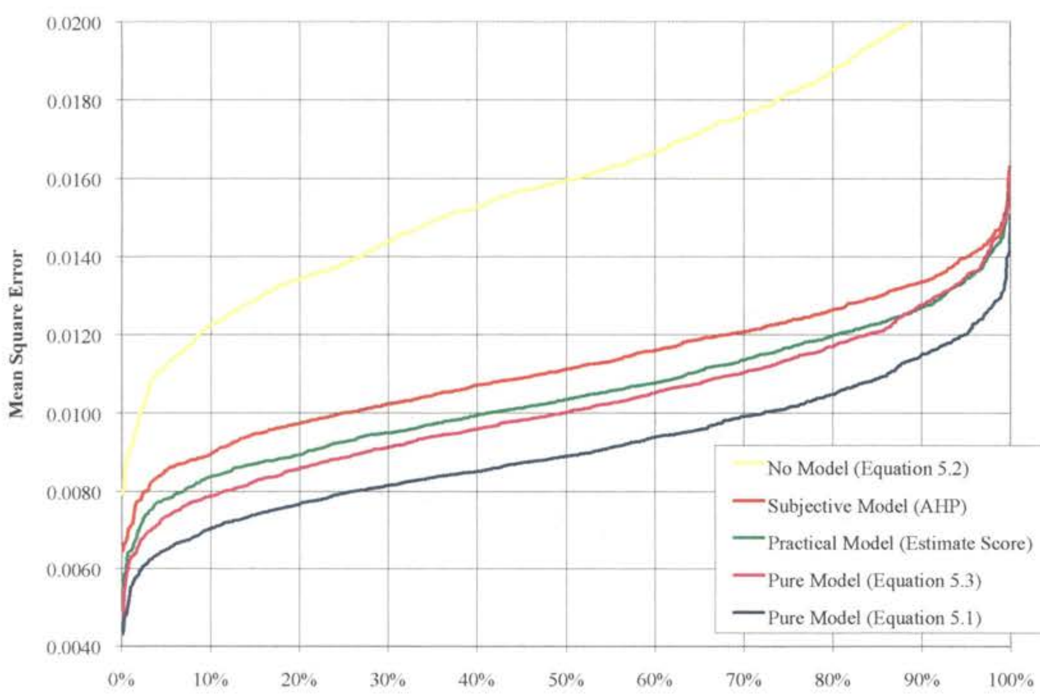


Figure 16 – Bootstrapping on Mean Square Error

The "Practical" Model – Estimate Score

The pure models described above provide adequate quantitative predictions of estimate accuracy. However, the derived models may or may not be best for the various subdivisions within the process industry. In addition, calculating individual element weights from the complete factor scores (for the pure models) yields counter-intuitive results in that some of the elements receive negative weights.

The researchers sought to establish a practical model that would be based on statistical truth but would also satisfy the common sense aspects of estimate accuracy as well as provide for the possibility of future refinement. To accomplish this goal, the researchers decided to retain all eleven factors in the practical model even though only five were significant at the $\alpha = 10\%$ level. This was done in recognition of the fact that some of the insignificant elements in this research may be significant to certain subdivisions within the process industry.

In addition, the researchers decided to weight each of the forty-five elements based on abbreviated factor scores rather than complete factor scores. As such, each of the elements was weighted based solely on the factor upon which that particular element exhibited the greatest influence. Thus, each element was associated with only one factor even though, as can be seen by the rotated factor-loading matrix in Table 3, each element exhibited *some* influence on each of the eleven factors.

Factor and Element Weights

The element weights and element score values were developed from the rotated factor-loading matrix (Table 3) and the regression of percent cost overrun on the eleven factors with two exceptions as noted below. The weights for the elements in Factors 6 and 7 were based on a minimum threshold value rather than the regression parameter estimates for those factors. Factors 6 and 7 both received negative parameter estimates during the regression analysis. A practical consideration of the elements contained in Factors 6 and 7 led the researchers to replace the negative parameter estimates obtained from the regression analysis with a nominal non-zero, non-negative value. This was done in recognition of the fact that negative element weights run counter to the one-to-five best-to-worst rating system that forms the basis of the Estimate Score procedure. A small nominal value was chosen in recognition of the fact that the data in no way support a strong positive correlation between percent cost overrun and either Factor 6 or Factor 7. Factors 6 and 7 were not eliminated from the model in recognition of the fact that additional data and future analysis may show that the elements in those factors may be important to other sectors of the construction industry. For instance, the fact that few of the observed projects contained "new" or "unproven" technology may account for the lack of significant positive correlation on Factor 7 (*technology issues*).

Once the parameter estimates for Factors 6 and 7 were replaced, the parameter estimates for all eleven factors were normalized to one hundred. The normalized parameter estimates are referred to as "factor weights" and are shown in Table 8. Individual element weights were computed by multiplying the factor weights by the rotated factor-loading matrix (Table 3). The element weights were computed for the primary elements of each factor based on the ratio of the primary elements loading on that factor divided by the sum of the loadings of the primary elements for that factor. Table 9 summarizes the calculations of the element weights for Factor 2 (*basic process design*). This procedure was used on all of the factor groups to determine the individual element weights.

The element weight represents the element score that would result from a rating of five (i.e. worst) for that element. The sum of all the element weights for the forty-five elements equals one hundred. Thus, the worst possible Estimate Score (all fives) is one hundred. In addition to the element weights, an element score value was derived from the element weights for each of the other possible ratings (one through four) for each element. Table 10 shows the individual element score values for each possible rating based on the factor weights presented in Table 8.

Table 8 – Factor Weights for the Eleven Factors

Factor Description	Factor #	Factor Weight	Cum. Weight
Basic process design	2	25.0	25.0
Team experience and cost information	5	14.3	39.3
Time allowed to prepare the estimate	10	13.0	52.3
Site requirements	4	12.4	64.8
Bidding/labor climate	3	11.0	75.7
Team alignment	9	8.8	84.5
Owner's costs	11	7.3	91.8
Contingency and reviews	8	3.8	95.6
Formal estimating process	1	2.1	97.6
Money issues	6	1.2	98.8
Technology issues	7	1.2	100.0

Table 9 – Element Weight Calculations for Factor 2 (*Basic Process Design*)

Element #	Factor Loading (1)	Total of Factor Loadings (2) = Σ (1)	% of Total (3) = (1) / (2)	Factor 2 Weight (4)	Element Weight (5) = (3) * (4)
3.8	0.78	3.92	19.9%	25.0	5.0
3.10	0.76	3.92	19.4%	25.0	4.8
3.14	0.67	3.92	17.1%	25.0	4.3
3.1	0.61	3.92	15.5%	25.0	3.9
3.9	0.59	3.92	15.2%	25.0	3.8
3.11	0.51	3.92	13.1%	25.0	3.3

Table 10 – Element Score Values for the "Practical" Model (Estimate Score)

Element #	Element Rating & Score				
	1	2	3	4	5
1.1	0.1	0.9	1.8	2.7	3.6
1.2	0.0	0.5	0.9	1.4	1.8
1.3	0.0	0.8	1.6	2.4	3.2
1.4	0.0	0.0	0.1	0.1	0.2
1.5	0.0	0.5	1.1	1.6	2.1
1.6	0.0	0.4	0.8	1.2	1.6
1.7	0.0	0.8	1.5	2.3	3.1
1.8	0.0	0.1	0.1	0.2	0.2
1.9	0.0	0.1	0.1	0.2	0.2
2.1	0.0	0.5	0.9	1.4	1.9
2.2	0.0	0.5	1.1	1.6	2.2
2.3	0.0	0.7	1.4	2.1	2.8
2.4	0.0	0.1	0.1	0.2	0.3
2.5	0.2	3.2	6.5	9.7	13.0
2.6	0.0	0.0	0.1	0.1	0.2
2.7	0.0	0.1	0.1	0.2	0.3
2.8	0.0	0.1	0.1	0.2	0.3
2.9	0.0	0.1	0.1	0.2	0.2
2.10	0.0	0.1	0.1	0.2	0.3
2.11	0.0	0.5	1.1	1.6	2.2
3.1	0.1	1.0	1.9	2.9	3.9
3.2	0.0	0.1	0.3	0.4	0.5
3.3	0.0	0.1	0.2	0.3	0.4
3.4	0.0	0.4	0.9	1.3	1.7
3.5	0.1	0.8	1.7	2.5	3.4
3.6	0.0	0.7	1.3	2.0	2.6
3.7	0.0	0.5	1.1	1.6	2.1
3.8	0.1	1.2	2.5	3.7	5.0
3.9	0.1	0.9	1.9	2.8	3.8
3.10	0.1	1.2	2.4	3.6	4.8
3.11	0.0	0.8	1.6	2.5	3.3
3.12	0.0	0.1	0.1	0.2	0.3
3.13	0.0	0.6	1.3	1.9	2.5
3.14	0.1	1.1	2.1	3.2	4.3
4.1	0.1	1.8	3.7	5.5	7.3
4.2	0.0	0.0	0.1	0.1	0.2
4.3	0.0	0.4	0.7	1.1	1.4
4.4	0.0	0.6	1.3	1.9	2.5
4.5	0.0	0.1	0.2	0.2	0.3
4.6	0.0	0.6	1.2	1.8	2.4
4.7	0.0	0.6	1.2	1.8	2.3
4.8	0.0	0.7	1.5	2.2	2.9
4.9	0.0	0.1	0.2	0.3	0.4
4.10	0.0	0.1	0.1	0.2	0.3
4.11	0.0	0.4	0.9	1.3	1.7

Estimate Score Calculation

The user rates each of the elements from one to five with one being "best" and five being "worst". The element score for each element is then determined from the table of estimate score values (Table 10). The final Estimate Score can then be calculated as the sum of the element scores for each element. The best possible Estimate Score (all ones) is one and the worst possible Estimate Score is one hundred. Thus the Estimate Score is a value between one and one hundred with a lower score depicting a higher quality estimate.

Prediction of Estimate Accuracy using the Estimate Score

An ordinary least-squares (OLS) fit through the data provides the point prediction of the accuracy of an early estimate. The OLS provides an estimate of the slope (*m*) and intercept (*b*) of the prediction model (y = *m*x + *b*). In addition, prediction bands are computed based on Equation 5.4.

$$PL_{U,L} = \hat{y}_t \pm t_c \cdot \sqrt{\hat{\sigma}^2 \left[1 + \frac{1}{T} + \frac{(x_0 - \bar{x})^2}{\sum (x_t - \bar{x})^2} \right]} \qquad \text{Equation 5.4}$$

where

$PL_{U,L}$ = upper and lower prediction limits

$\hat{y}_t$ = predicted value

t_c = critical value from $t_{(T-2)}$ distribution such that $P(t \geq t_c) = \alpha/2$

$1 - \alpha$ = confidence interval such that $P(PL_L \leq \hat{y}_t \leq PL_U) = 1 - \alpha$

$\hat{\sigma}^2$ = estimated error variance, $\hat{\sigma}^2 = SSE/(T-2)$

SSE = Sum of Squared Errors of the model

T = number of observations

x_0 = Estimate Score value

$\bar{x}$ = average Estimate Score value of sample

x_t = Estimate Score value of observation t.

Sample Prediction Curves

Figure 17 represents a scatter plot with 10/90 prediction bands (eighty-percent confidence level) for the twenty chemical manufacturing projects in the database. The 10/90 prediction bands represent the limits of a ten-percent and ninety-percent probability of cost underrun respectively. As such, a new project has an eighty percent chance, on average, of ending up between the upper and lower limits of the 10/90 prediction bands (80 = 90 – 10). For instance, Figure 17 suggests that an estimate with an Estimate Score of twenty has, on average, an eighty-percent chance of falling within 18.9% above and 7.9% below the base estimate. Similarly, an estimate with an Estimate Score of twenty has a ninety-percent chance of underruning if 18.9% contingency is added to the base estimate.

A cumulative probability curve, commonly called an S-Curve, provides an alternative way to view this information. Figure 18 represents the cumulative distribution curve based on the twenty chemical manufacturing projects identified in Figure 17 and an Estimate Score of twenty. This type of graph provides information about the entire range of confidence intervals and underrun probabilities for a given Estimate Score.

Appendix E presents various prediction curves including all sixty-seven projects in the database as well as the twenty chemical manufacturing projects, nine electrical generation projects, ten pulp and paper projects and ten oil refinery projects in the database. Similarly, prediction curves for the nineteen add-on and modernization projects, twenty-six conversion projects and sixteen grassroots projects in the database are presented. Predictions based on Estimate Scores outside the observed range of historical Estimate Scores are unreliable and should be used with caution. In Figure 17, this would apply to an estimate with an Estimate Score less than fifteen or greater than fifty-five. This warning also applies whenever a relatively small number of historical data are available (i.e. less than ten).

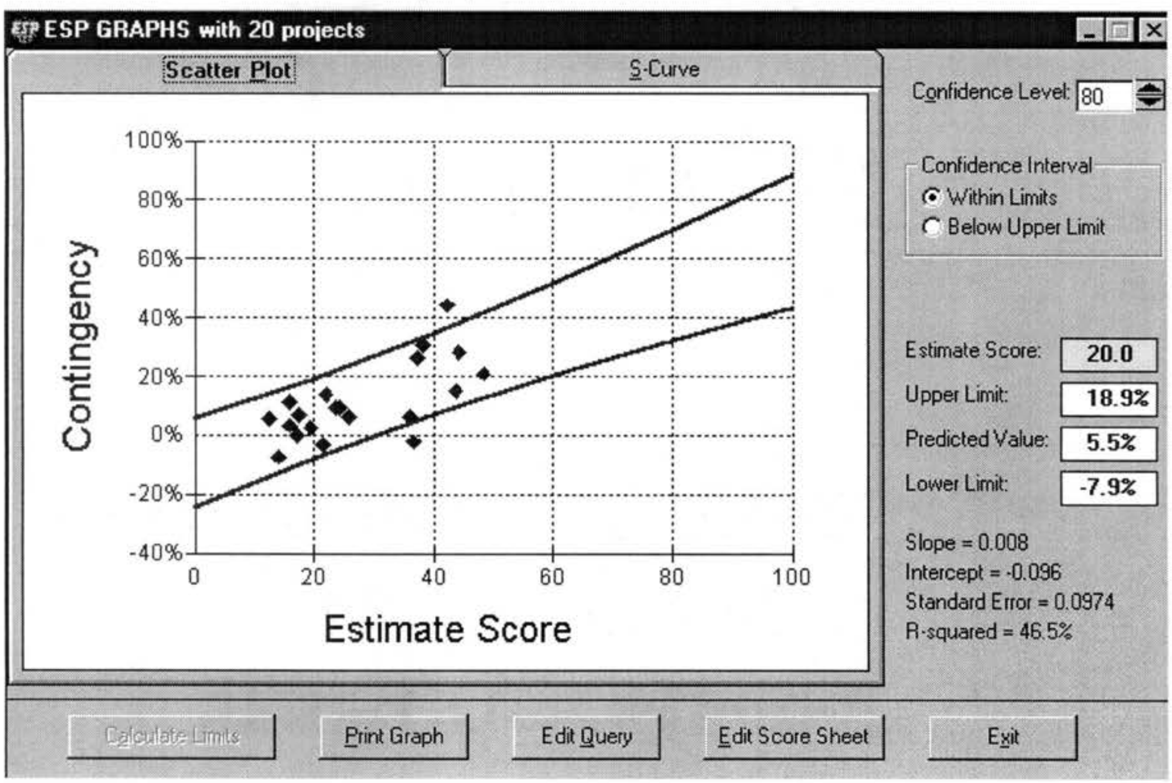


Figure 17 – Sample Scatter Plot (Chemical Manufacturing)

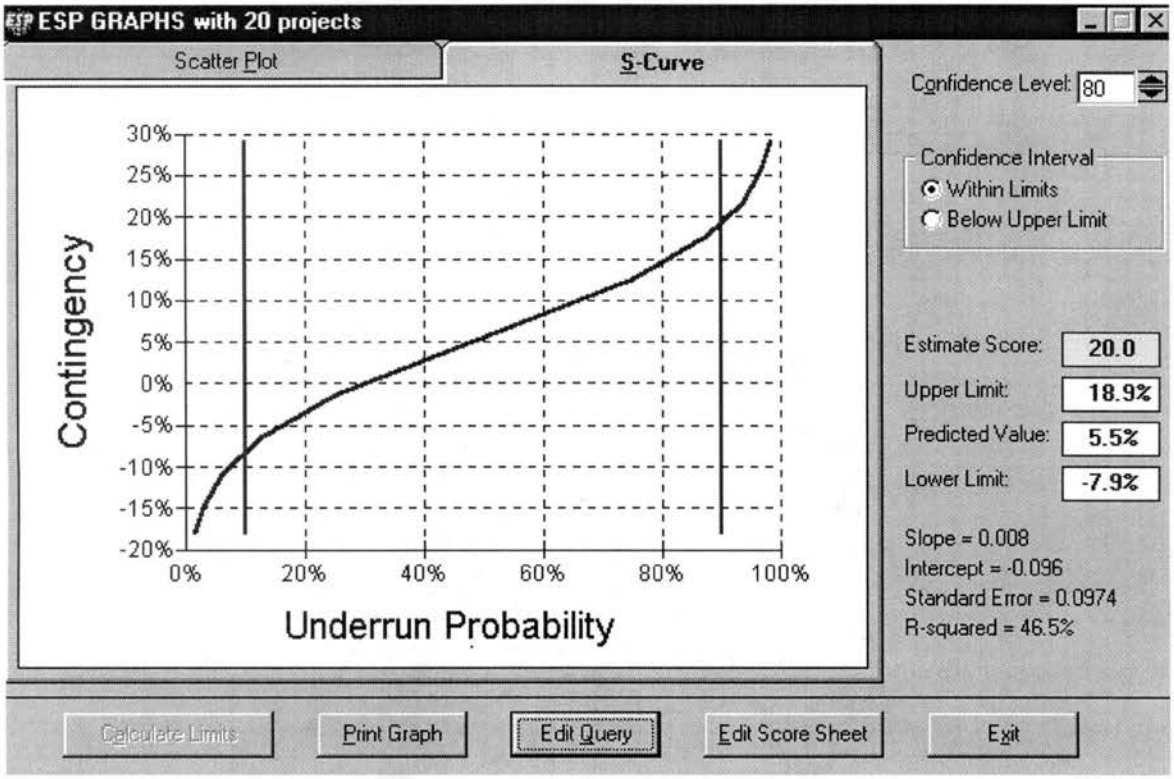


Figure 18 – Sample Cumulative Distribution Graph
(Chemical Manufacturing with Estimate Score = 20)

CHAPTER VI

IMPLEMENTATION OF THE RESULTS USING THE ESTIMATE SCORE PROGRAM (ESP)

The Estimate Score Program (ESP) was developed as a tool to implement and automate the scoring process for an early estimate as well as the analysis process. The scoring of an early estimate occurs through the Estimate Score Sheet portion of the program while the analysis is accomplished through the Query, Scatter Plot and Cumulative Graph portions of the software. In addition, a Historical Statistics module of the program can be utilized to perform "reality checks" during actual estimate preparation to allow the user to evaluate estimated cost ratios for comparison with historical cost data. A user's guide to ESP can be found in Appendix F. Appendix G through Appendix I contain the ESP code and information about the database that drives ESP.

Estimate Score Sheet

The Estimate Score Sheet portion of ESP functions as the input engine of the program and automates the estimate scoring process. This is accomplished through the use of five tabs–Project Info, Division 1, Division 2, Division 3 and Division 4. The Project Info tab (Figure 19) provides the means for inputting project-specific information, such as location, project type and so forth as well as estimate-specific information such as estimated construction costs, chief estimator and estimate date. Each of the four division tabs (Figure 20 through Figure 23) enables the user to rate the elements of that particular division. ESP automatically calculates individual division scores as well as the overall Estimate Score as the user rates each of the elements on a one-to-five scale.

The element scores themselves are based on the element weights developed during the factor and regression analyses described in Chapter V. The individual element weights represent the element score corresponding to an element rating of five, which is the worst possible rating an element can receive. The sum of all element weights is one hundred. Thus, the worst possible Estimate Score, corresponding to a rating of five on all elements, would be one hundred. By contrast, the best possible Estimate Score (a rating of one for all elements) is one. The individual element scores for each possible rating were given in Table 10.

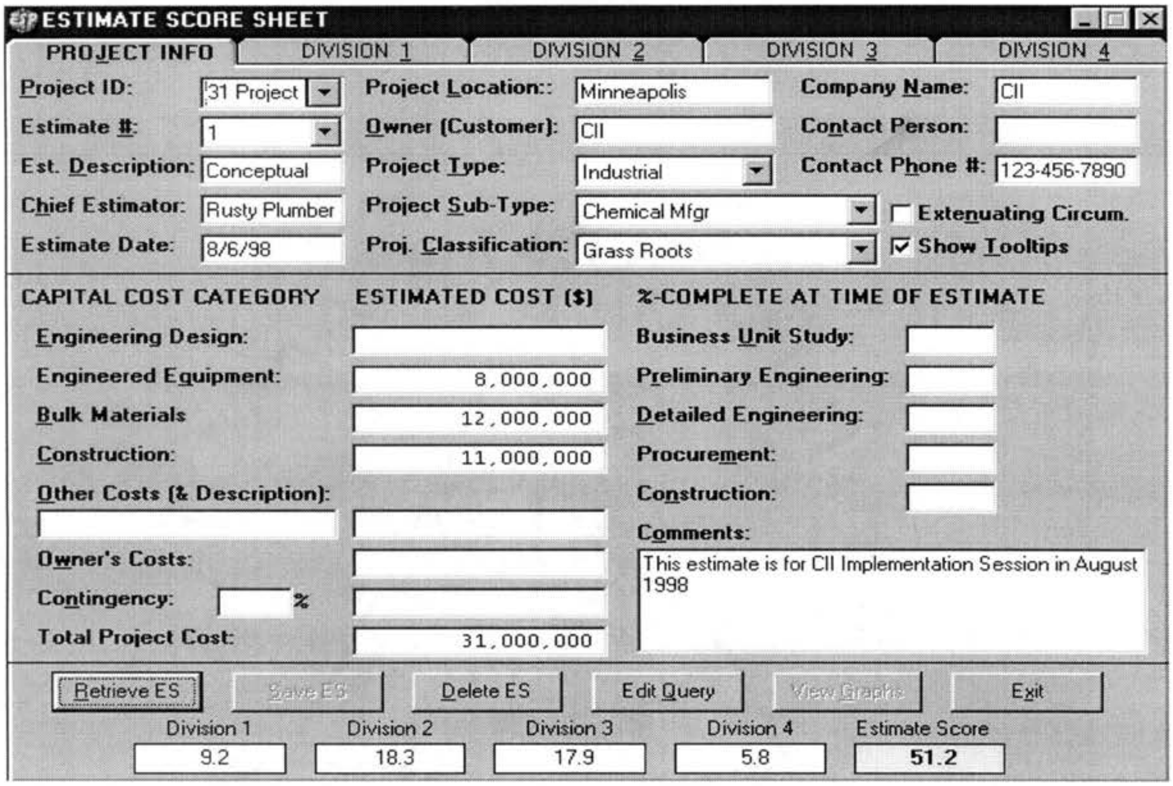


Figure 19 – Sample Project Info Tab

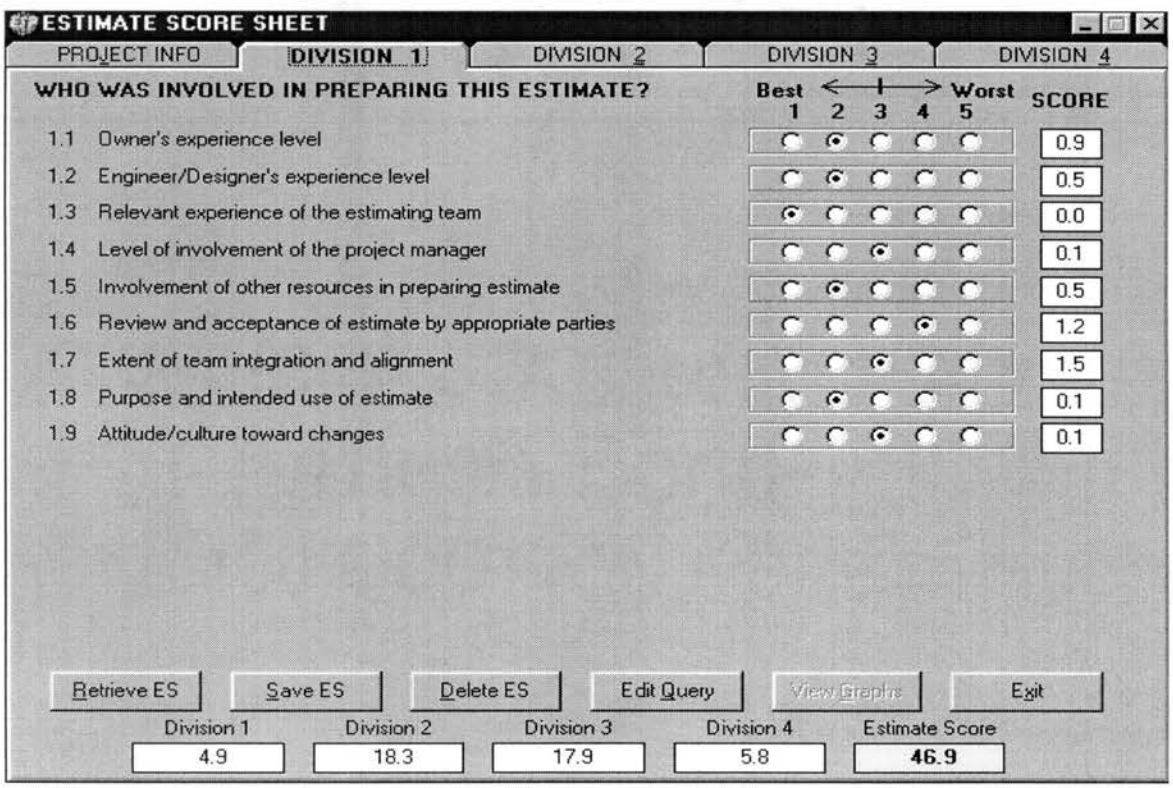


Figure 20 – Sample Division 1 Tab (Who was Involved in Preparing the Estimate?)

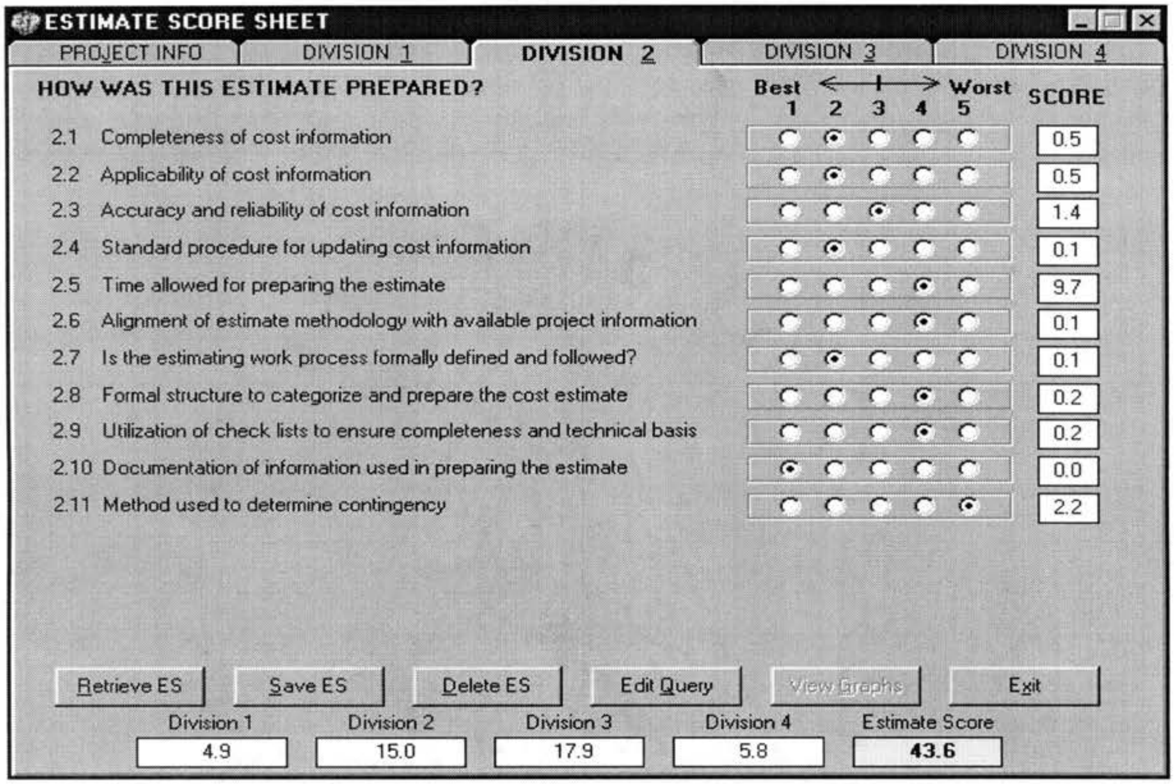


Figure 21 – Sample Division 2 Tab (How was the Estimate Prepared?)

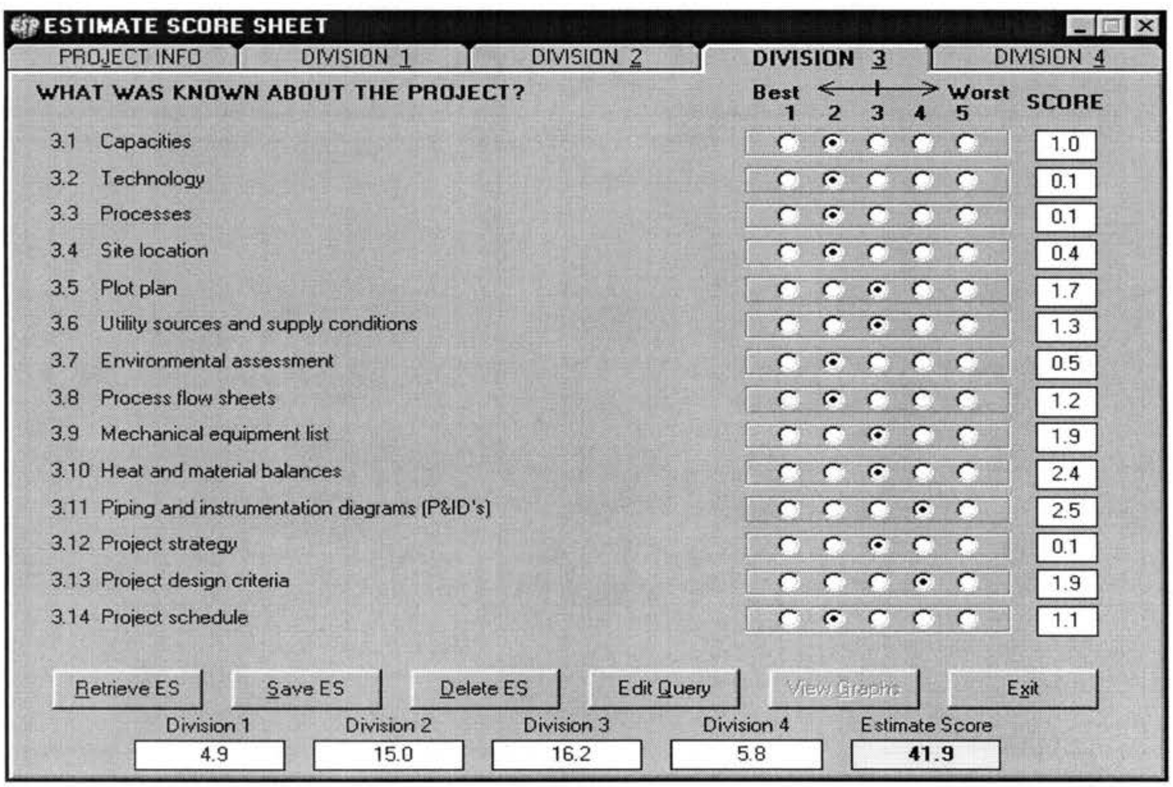


Figure 22 – Sample Division 3 Tab (What was Known about the Project?)

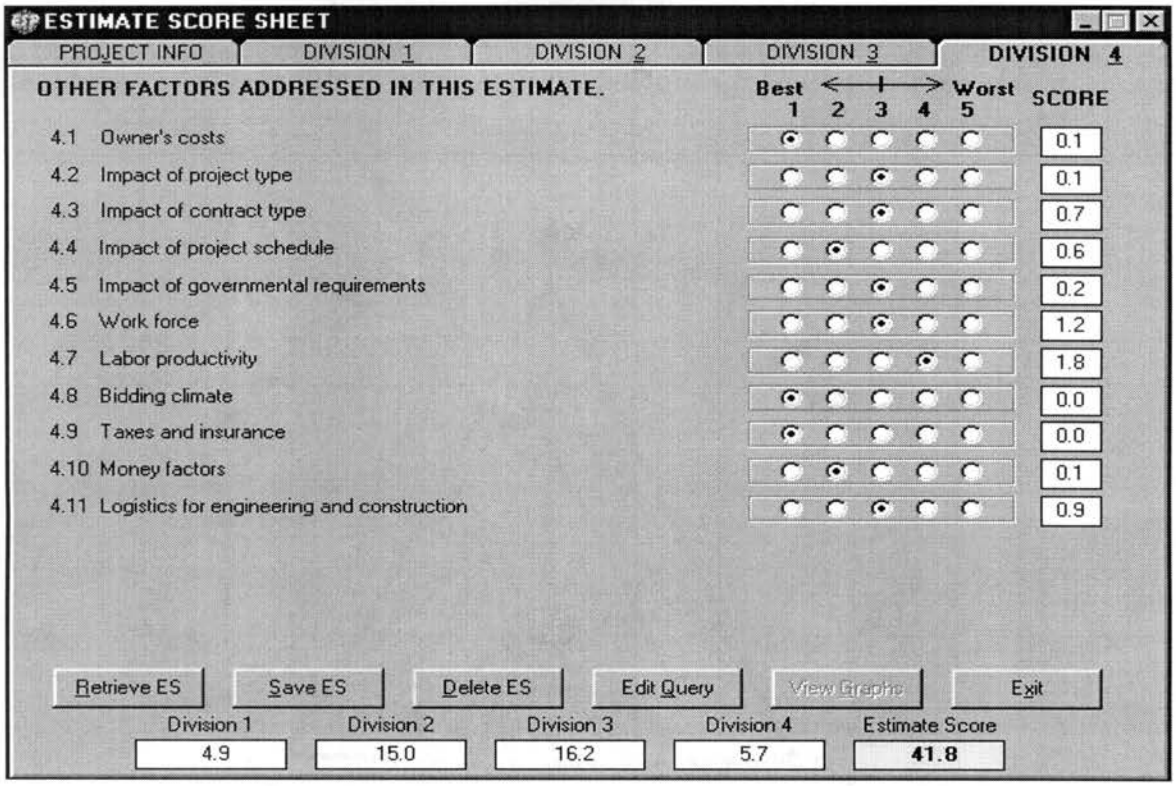


Figure 23 – Sample Division 4 Tab (Other Factors Addressed in this Estimate?)

Query of the Completed Projects Database

The user can query the database of completed projects to specifically identify those projects that most closely match the project currently being estimated. The query can encompass virtually any aspect of the project for which information has been stored in the database, such as estimated and actual costs, project location, project type or sub-type, etc.

The user must weigh the trade-off between a close match with the current project and the number of projects returned from the query. Presumably a closer match will yield better predictive results. However, the predictive capability of the model also depends on the number of projects in the query as well as the amount of variability across those projects. A description of the process used in the prediction band calculations was presented in Chapter V. Figure 24 shows the Query form of ESP.

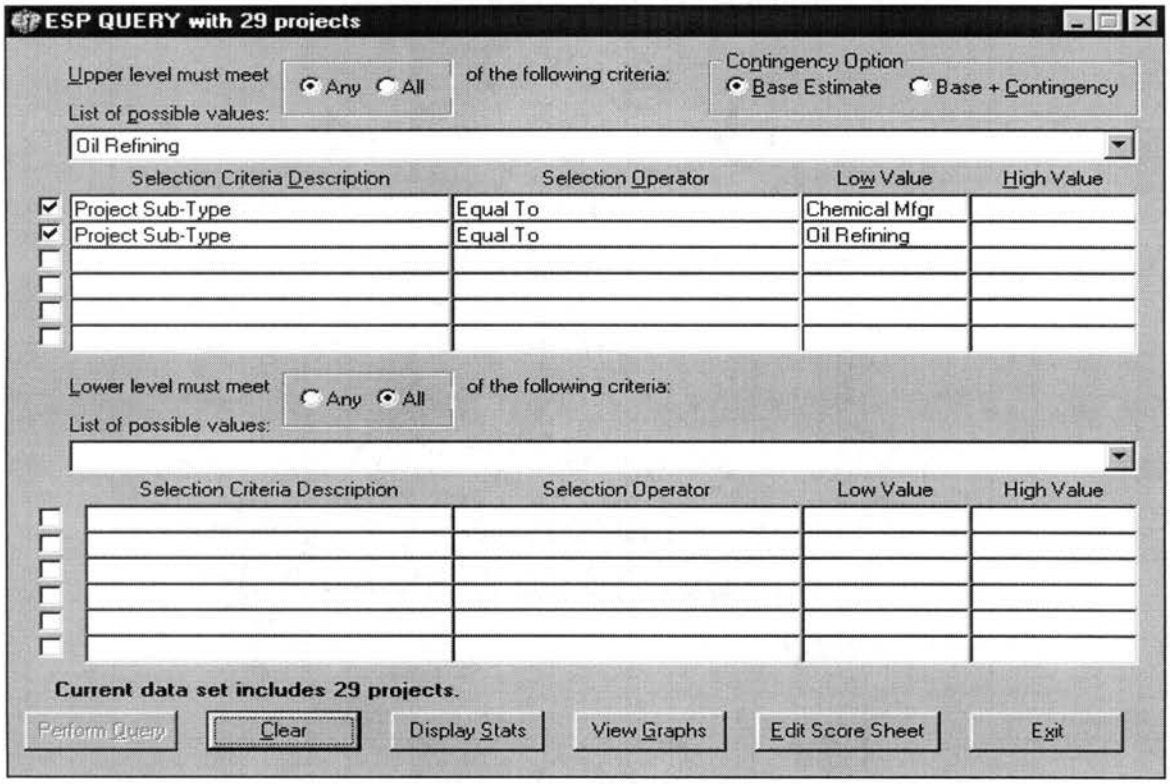


Figure 24 – Sample Query Form

Scatter Plot

The Scatter Plot shown in Figure 25 provides a means for the user to graphically view all of the project data returned from the query operation described above. On the Scatter Plot, each estimate from each completed project is identified as a single point on the graph. The estimate's Estimate Score value is displayed on the x-axis while the vertical axis displays the amount of contingency that should have been applied to the estimate in order to have achieved zero cost growth. Upper and lower prediction bands are displayed based on the queried projects and the chosen confidence level. In addition, upper and lower point estimates for recommended contingency are given based on the current project's Estimate Score for the chosen confidence level.

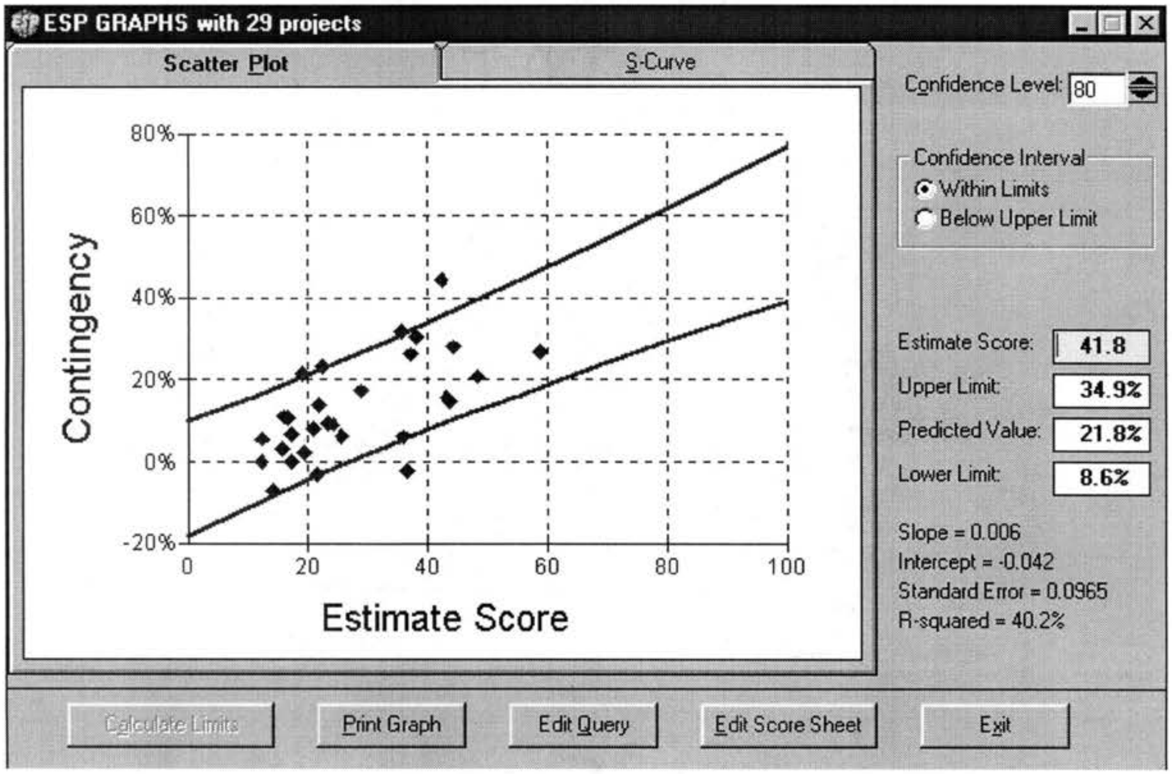


Figure 25 – Sample Scatter Plot

Cumulative Graph

The Cumulative Graph, or S-Curve, shown in Figure 26, provides a graphical representation of all possible confidence levels based on the queried projects and the current project's Estimate Score. The Cumulative Graph enables the user to make decisions about the level of confidence associated with a given contingency level and vice versa without the need to change the confidence level and then recalculate. The horizontal axis of the Cumulative Graph displays the probability of a project underruning as it corresponds to the amount of contingency to be added to the base estimate as a percentage (the y-axis value). Thus to determine how much contingency must be added to the base estimate in order to be 90% certain that the project will not underrun, draw an imaginary line from 90% on the x-axis up until it intersects the S-Curve. Then draw another imaginary line to the left until it intersects the y-axis. The corresponding y-axis value represents the amount of contingency required to meet the stated confidence requirement.

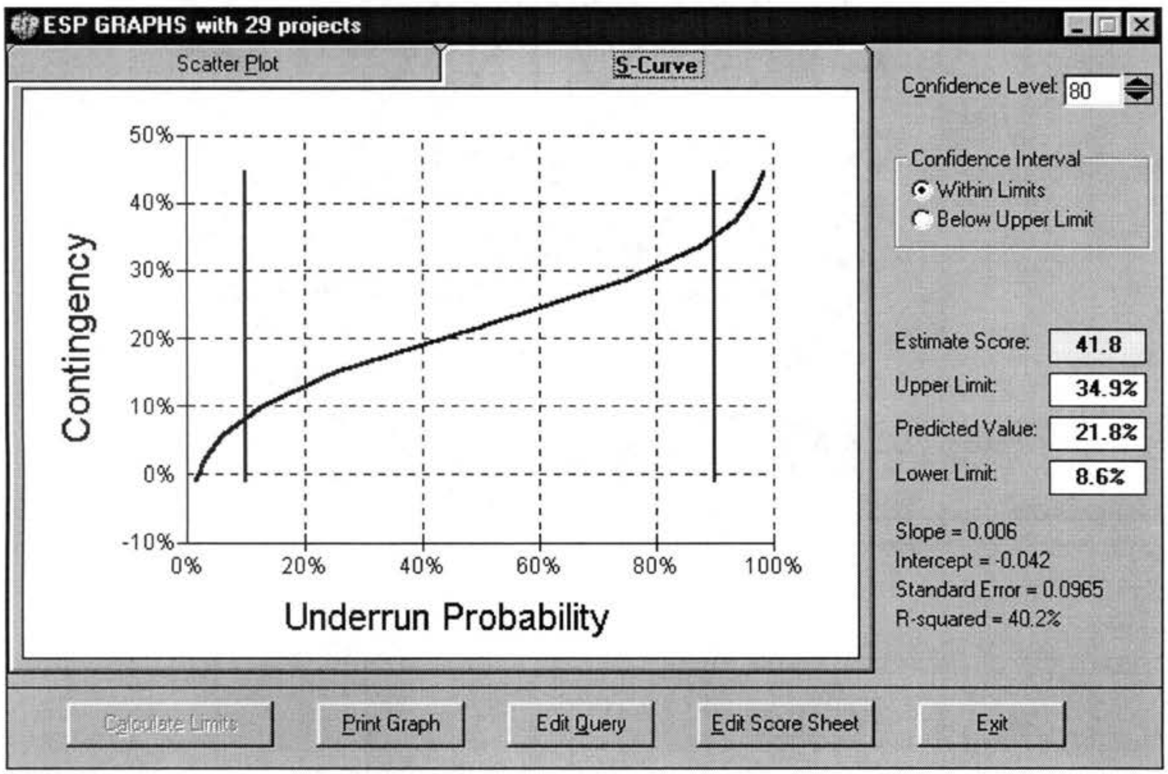
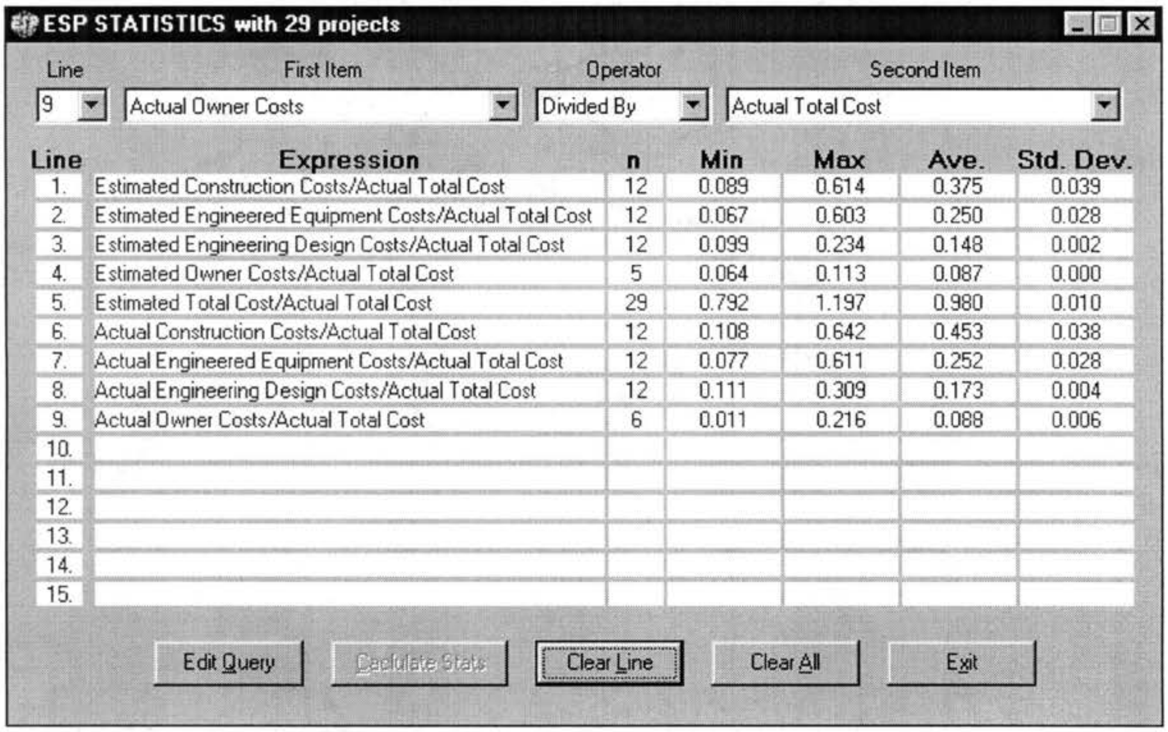


Figure 26 – Sample Cumulative Graph

Historical Statistics

In addition to using ESP to assign contingency to a project based on its Estimate Score, an estimator can actually use ESP during the development of the estimate itself. Through the historical statistics feature, ESP provides a means for an estimator to calculate desired statistics based on the queried projects as a cross check or reality check for a current estimate. For instance, the estimator can determine the average and standard deviation of actual engineering design costs as a percentage of actual construction costs. This percentage or ratio can then be compared back to the current estimate to determine the reasonableness of the estimated engineering design costs as they relate to the estimated construction costs. Figure 27 shows the form used to compare historical statistics.



Line	Expression	n	Min	Max	Ave.	Std. Dev.
1.	Estimated Construction Costs/Actual Total Cost	12	0.089	0.614	0.375	0.039
2.	Estimated Engineered Equipment Costs/Actual Total Cost	12	0.067	0.603	0.250	0.028
3.	Estimated Engineering Design Costs/Actual Total Cost	12	0.099	0.234	0.148	0.002
4.	Estimated Owner Costs/Actual Total Cost	5	0.064	0.113	0.087	0.000
5.	Estimated Total Cost/Actual Total Cost	29	0.792	1.197	0.980	0.010
6.	Actual Construction Costs/Actual Total Cost	12	0.108	0.642	0.453	0.038
7.	Actual Engineered Equipment Costs/Actual Total Cost	12	0.077	0.611	0.252	0.028
8.	Actual Engineering Design Costs/Actual Total Cost	12	0.111	0.309	0.173	0.004
9.	Actual Owner Costs/Actual Total Cost	6	0.011	0.216	0.088	0.006
10.						
11.						
12.						
13.						
14.						
15.						

Figure 27 – Sample Historical Statistics Form

CHAPTER VII

SUMMARY / CONCLUSION / RECOMMENDATIONS

Summary

The importance of accurate estimates during the early stages of capital projects has been widely recognized for many years. Early project estimates represent a key ingredient in business unit decisions and often become the basis for the project's ultimate funding. However, objective, quantitative measures for predicting the accuracy of early project estimates have been heretofore extremely scarce. The "Improving Early Estimates" research team of the Construction Industry Institute established a quantitative method (the Estimate Score procedure) for predicting estimate accuracy based on forty-five key elements. The elements refer to *who* was involved in preparing the estimate, *how* the estimate was prepared, *what* was known about the project and *other factors* affecting the estimate. The research team also developed a computer software program (the Estimate Score Program, or ESP) to implement and automate the above-mentioned procedure.

A two-page questionnaire was developed to collect data on completed construction projects from the process industry. The questionnaire requested estimated and actual cost information in addition to Estimate Score information as described above. Usable data were received for sixty-seven construction projects totaling \$5.6 billion. The data were analyzed using factor analysis and multivariate regression.

The data analysis identified eleven factors, five of which were significant at the $\alpha = 10\%$ level, that impact estimate accuracy. The five factors, in order of significance, were *basic process design, team experience and cost information, time allowed to prepare the estimate*, *site requirements* and *bidding and labor climate*. These five factors combined, representing twenty-three of the forty-five elements, account for 51% of the variation of the sample. The Estimate Score procedure includes all forty-five elements and can be used to predict the amount of contingency that should be added to an estimate based on a desired confidence level.

The Estimate Score Program (ESP) was developed to implement and automate the Estimate Score procedure. ESP allows the user to score an estimate and compare the resulting Estimate Score with similar projects from a database of completed projects. The current database contains the initial sixty-seven projects obtained from this research effort. However, the user can add company-specific project data to create an exclusive database of the company's actual project history.

Conclusion

As mentioned above, factor analysis and multivariate regression performed on the forty-five elements identified five factors that exhibit a significant impact on estimate accuracy. The most significant factor, *basic process design*, accounts for 25% of the Estimate Score. The elements that loaded highest on the basic process design factor were *process flow sheets*, *heat and material balance*, *project schedule*, *capacities*, *mechanical equipment list* and *piping and instrumentation diagrams*. A comprehensive and definitive process design is thus crucial to the accuracy of an early estimate of an industrial process facility. In addition to process design, identification of the basic site requirements of a project fulfills an important role in estimate accuracy. The *site requirements* factor accounts for 12.4% of the Estimate Score. The influence of these two scope definition factors comes as no surprise and further validates the work of Hackney (12, 13, 14) and Gibson and Dumont (7).

The second factor of significance, *team experience and cost information*, highlights the importance of the human factor in estimate preparation. This factor emphasizes the importance of the experience level not only of the estimating team but also of the engineering staff. In addition, the quality of the cost information plays a significant role in estimate accuracy. The fact that these issues (experience and cost information) loaded on a single factor suggests that experienced estimators play a significant role in determining and influencing the quality of cost information. The *team experience and cost information* factor accounts for 14.3% of the Estimate Score.

Time allowed to prepare the estimate ranked third among the significant factors influencing estimate accuracy. Adequate scope definition, an experienced project team and good cost information do not fully explain the estimate accuracy picture. They must be combined with an adequate allotment of time. Time allowed accounts for 13% of the Estimate Score. The inclusion of bidding and labor climate issues in the estimate also impacts overall estimate accuracy. The *bidding and labor climate* factor ranked fifth in significance and accounts for 11% of the Estimate Score.

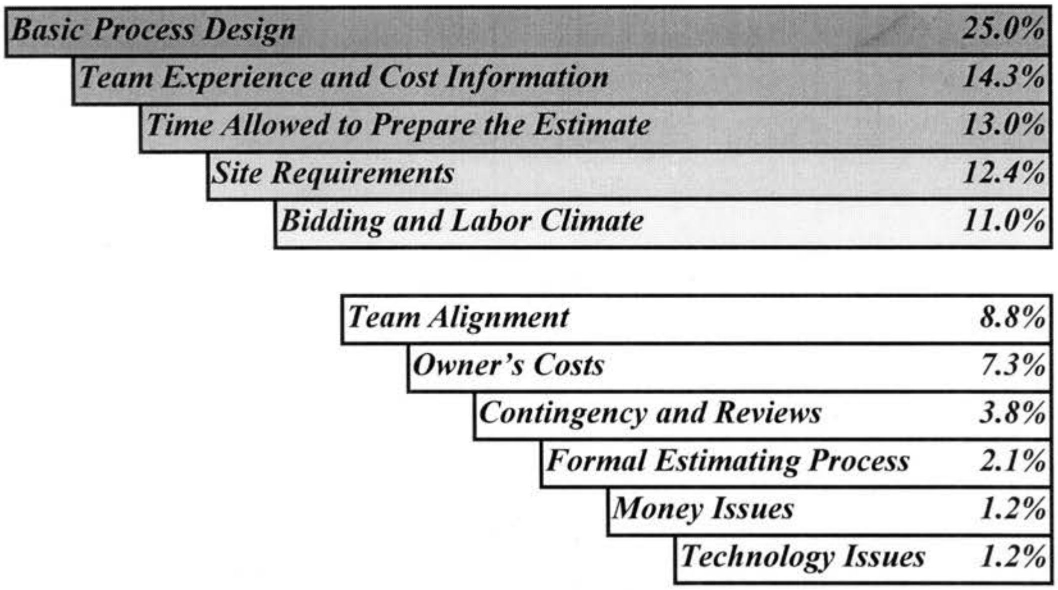


Figure 28 – The Drivers of Estimate Accuracy

Recommendations for Future Research

Although this research effort identified and quantified the drivers of estimate accuracy for capital projects in the process industry, construction projects in the building and infrastructure sectors were not considered. Future research is needed to adequately identify and quantify the drivers of estimate accuracy as they relate to the construction of buildings and infrastructure projects. In addition, the lack of projects utilizing new and unproven technologies in this research highlights the need for additional analysis once additional project data become available.

The researchers developed the Estimate Score procedure and Estimate Score Program such that the procedure can function not only as a prediction tool but also as a data collection tool to facilitate future analysis. As additional data become available, future analysis could potentially identify different factor groups and/or different factor weights depending on items such as project sub-type, geographic location, project classification and so forth.

Figure 29 below depicts a hypothesis that this research team developed regarding the influence of non-scope items on estimate accuracy over the life of a project (25).

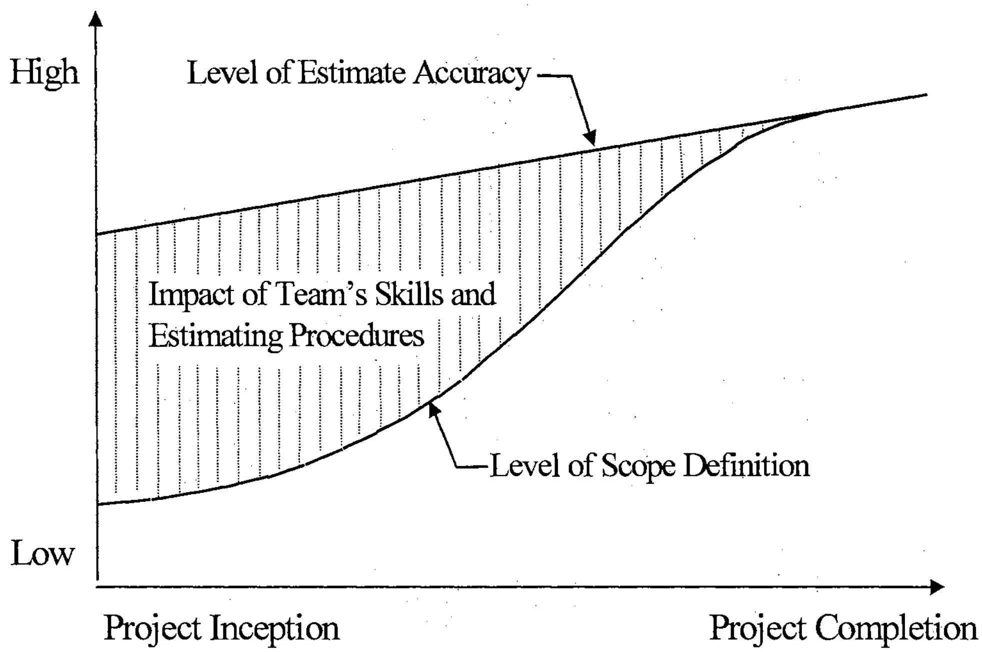


Figure 29 – Estimate Accuracy and the Project Timeline

If this hypothesis is correct, the relative influence of the estimate drivers may actually change as a project progresses from the conceptual stage to the bid phase. In that case, the Estimate Score computations would need to be based on a dynamic set of factor and element weights. Future research should be conducted to determine potential variation in estimate drivers with respect to the time-line of the project. To accomplish that goal, an appropriate measure of the project time-line would first need to be established. This may be difficult to perform because substantial overlap can occur between the various phases of a construction project.

A SELECTED BIBLIOGRAPHY

(1) Association for the Advancement of Cost Engineering. *Recommended Practice: Cost Estimate Classification System (18R-97).* Morgantown, WV: AACE International, 1997.

(2) Bakewell, Robert D. "Theoretical and practical aspects of conceptual estimating." *Cost Engineering*, Vol. 27, No. 2 (February 1985), pp. 18-20.

(3) Cabral, Gregory K. "Techniques for capital cost estimating with minimal data." *Cost Engineering*, Vol. 24, No. 5 (October 1982), pp. 269-272.

(4) de la Garza, Jesus M. and Rouhana, Khalil G. "Neural networks versus parameter-based applications in cost estimating." *Cost Engineering*, Vol. 37, No. 2 (February 1995), pp. 14-18.

(5) El-Choum, Mohamed K. *Identification and Modeling of Construction Cost Overrun Parameters for Public Infrastructure Projects using Multivariate Statistical Methods.* Hoboken, NJ: Stevens Institute of Technology (Ph.D. Dissertation), 1994.

(6) El-Choum, Mohamed K. "Model building strategy for construction cost overruns." *Transactions of AACE International.* (1995), pp. D&RM.4.1-D&RM.4.9.

(7) Gibson, G. Edward, Jr. and Dumont, Peter R. *Project Definition Rating Index for Industrial Projects.* Austin, TX: Construction Industry Institute (Research Report 113-11), 1995.

(8) Gibson, G. Edward, Jr. and Hamilton, Michele R. *Analysis of Pre-Project Planning Effort and Success Variables for Capital Facility Projects.* Austin, TX: Construction Industry Institute (Source Document 105), 1994.

(9) Gibson, G. Edward, Jr., Kaczmarowski, Jerome H. and Lore, H. Edgar, Jr. *Modeling Pre-Project Planning for the Construction of Capital Facilities.* Austin, TX: Construction Industry Institute (Source Document 94), 1993.

(10) Graf, M. W. "An overview of contingency considerations." *Cost Engineering*, Vol. 26, No. 1 (February 1984), pp. 25-34.

(11) Hackney, John W. "Accuracy of hazardous waste project estimates." *Transactions of the American Association of Cost Engineers*. (1989), pp. O.1.1-O.1.7.

(12) Hackney, John W. "Applied contingency analysis." *Transactions of the American Association of Cost Engineers*. (1985), pp. B.2.1-B.2.4.

(13) Hackney, John W. *Control and Management of Capital Projects*. New York, NY: John Wiley & Sons, Inc., 1965.

(14) Hackney, John W. *Control and Management of Capital Projects*. New York, NY: McGraw-Hill, Inc., 1992.

(15) Hollmann, John K. "A parametric building cost estimating system." *Transactions of AACE International*. (1994), pp. EST.4.1-EST.4.7.

(16) Hollmann, John K. and Dysert, Larry R. "The evolution of estimating systems at Kodak." *Transactions of AACE International*. (1996), pp. EST.8.1-EST.8.6.

(17) Jeffery, Joseph R. "Capital cost estimating for the frontier regions of the world: questions a savvy estimator should ask first." *Cost Engineering*, Vol. 36, No. 6 (June 1996), pp. 33-35.

(18) Merrow, Edward K. *Constraints on the Commercialization of Oil Shale*. Santa Monica, CA: Rand Corporation, 1978.

(19) Merrow, Edward K., Chapel, Stephen W. and Worthing, Christopher. *A Review of Cost Estimation in New Technologies: Implications for Energy Process Plants*. Santa Monica, CA: Rand Corporation, 1979.

(20) Merrow, Edward K. *Understanding Cost Growth and Performance Shortfalls in Pioneer Process Plants*. Santa Monica, CA: Rand Corporation, 1981.

(21) Merrow, Edward K. "Understanding the costs and schedule of hydroelectric projects." *Transactions of the American Association of Cost Engineers*. (1991), pp. I.3.1-I.3.7.

(22) Morris. *Improving the Accuracy of Early Cost-Estimates for Federal Construction-Projects*. Washington DC: Building Research Board, National Research Council, 1990.

(23) Moselhi, Osama. "Risk assessment and contingency estimating." *Transactions of AACE International*. (1997), pp. D&RM/A.06.01-D&RM/A.06.6.

(24) O'Conner, J. T. and Vickroy, C. G. *Control of Construction Project Scope*. Austin, TX: Construction Industry Institute (Source Document 6), 1986.

(25) Oberlender, G. D. et al. *Improving Early Estimates–Best Practices Guide*. Austin, TX: Construction Industry Institute (Implementation Resource 131-2), 1998.

(26) Parker, Donald, E. "Project budgeting for buildings." *Cost Engineering*, Vol. 36, No. 12 (December 1994), pp. 13-18.

(27) Skitmore, Martin. "Factors affecting the accuracy of engineers' estimates." *Transactions of the American Association of Cost Engineers*. (1988), pp. B.3.1-B.3.8.

(28) Stevens, G. and Davis, T. "How accurate are capital cost estimates?" *Transactions of the American Association of Cost Engineers*. (1988), pp. B.4.1-B.4.5.

(29) Stevenson, James J., Jr. "Determining meaningful estimate contingency." *Cost Engineering*, Vol. 26, No. 1 (February 1984), pp. 35-41.

(30) Uher, Thomas, E. "A probabilistic cost estimating model." *Cost Engineering*, Vol. 38, No. 4 (April 1996), pp. 33-40.

(31) United States Department of Energy, Office of Environmental Restoration and Waste Management and Independent Project Analysis, Inc. *The Department of Energy Office of Environmental Restoration & Waste Management Project Performance Study*. Springfield, VA: Technical Information Service, 1993.

(32) Uppal, Kul B. "How to establish an estimating department." *Cost Engineering*, Vol. 37, No. 9 (September 1995), pp. 15-18.

(33) Webb, Alan. "Risk analysis for business decisions Part 1." *Engineering Management Journal*, Vol. 4, No. 4 (August 1994), pp. 177-182.

(34) Webb, Alan. "Risk analysis for business decisions Part 2." *Engineering Management Journal*, Vol. 4, No. 5 (October 1994), pp. 223-230.

(35) Wendel, Donald. "Contingency estimating for environmental remediation projects." *Cost Engineering*, Vol. 37, No. 11 (November 1995), pp. 43-46.

(36) Wright, P. A. and Hill, T. V. "Cost estimating–dealing with uncertainty." *Transactions of the American Association of Cost Engineers*. (1986), pp. E.5.1-E.5.7.

APPENDICES

APPENDIX A

ELEMENT DESCRIPTIONS AND SUGGESTED RATINGS

Division 1 – Who Was Involved in Preparing the Estimate?

1.1 Owner's experience level

The owner's experience level influences project outcome. Consider the following:

- owner's experience with the technology
- owner's project team experience in project execution

Suggested Rating Scale for Element 1.1:

What is the level of experience of the owner?

1. Very high
2. High
3. Moderate
4. Low
5. Very low or unknown

1.2 Engineer/Designer's experience level

The experience level of the engineer/designer influences project outcome. Consider the following:

- engineers/designers experience with technology
- engineers/designers project team experience in project execution

Suggested Rating Scale for Element 1.2:

What is the level of experience of the engineer/designer(s)?

1. Very high
2. High
3. Moderate
4. Low
5. Very low or unknown

1.3 Relevant experience of the estimating team

Some of the following factors may be more relevant than others for a particular project and should be considered appropriately:

- experience with similar project types
- experience with projects of similar size
- general estimating experience
- knowledge of design and construction processes
- location familiarity
- company/client experience

Suggested Rating Scale for Element 1.3:

How relevant is the experience of the estimating team?

1. Relevant experience in almost all of the above factors
2. Relevant experience in most of the above factors
3. Relevant experience in some of the above factors
4. Relevant experience in few of the above factors
5. Relevant experience in almost none of the above factors

1.4 Level of involvement of the project manager

The level of involvement of the project manager influences the project outcome. Consider the following questions:

- Has he/she been involved in the estimate?
- Does he/she have ownership?
- Will he/she carry the project through to the end?
- Is there a procedure for approval and sign off of the estimate?
- Has the project manager signed off on the estimate?

Suggested Rating Scale for Element 1.4:

What is the level of involvement of the project manager?

1. Responsible for execution of budget and complete agreement with the estimate
2. Responsible for execution of budget and highly committed to the estimate
3. Responsible for execution of budget and generally committed to the estimate
4. Responsible for execution of budget, but minimum involvement in the estimate
5. Not responsible for execution of budget or involved in the estimate

---

1.5 Involvement of other resources in preparing the estimate

Other resources are often required in preparing the estimate. Below is a typical list of other resources:

- project team
- construction contractor(s)
- vendors / subcontractors
- consultants
- operations & maintenance personnel
- financial personnel

Suggested Rating Scale for Element 1.5:

What was the level of relevant involvement of the above resources in developing *this* estimate?

1. Complete involvement of other resources
2. Major involvement of other resources
3. Some involvement of other resources
4. Minor involvement of other resources
5. Very minor involvement of other resources

1.6 Review and acceptance of estimate by appropriate parties

Appropriate parties to achieve understanding and acceptance should review the estimate.

Suggested Rating Scale for Element 1.6:

Were appropriate reviews conducted?

1. All appropriate reviews conducted
2. Most
3. Some
4. Few
5. No reviews conducted

1.7 Extent of team integration and alignment

Has an evaluation been made of the impact of team building, use of task forces, improved project communications, etc.:

- timely assignment of all key project participants
- continuity of key project team members
- use of team building techniques
- Has the team worked together before?

Suggested Rating Scale for Element 1.7:

To what extent have team integration and alignment issues been implemented in preparing *this* estimate?

1. Almost all issues implemented
2. Most of the issues implemented
3. Some of the issues implemented
4. Few of the issues implemented
5. Almost none of the issues implemented

1.8 Purpose and intended use of estimate

Is there a common goal for the estimate, i.e. no alternative agendas? Has there been a determination of the intended use of the estimate (funding, decision point to continue, etc.) What kind of decisions will be made based on this estimate?

Suggested Rating Scale for Element 1.8:

What is the alignment of *this* estimate?

1. Full agreement on goals and the decisions to be made
2. General agreement on goals and the decisions to be made
3. Partial agreement on goals and the decisions to be made
4. Limited agreement on goals or uncertainty on decisions to be made
5. No agreement on goals or the decisions to be made

1.9 Attitude/culture toward changes

The propensity for change is strongly influenced by the attitude/culture of the project parties toward change, particularly the owner.

Suggested Rating Scale for Element 1.9:

What is the attitude/culture toward changes?

1. Scope "freeze" points defined and rigidly adhered to
2. History of minor deviations from a no-change philosophy
3. History of some deviations from a no-change philosophy
4. Change management procedures not effective in controlling change
5. No philosophy of change control

Division 2 – How Was the Estimate Prepared?

Elements 2.1 through 2.4 relate to the completeness, applicability, accuracy and reliability of the cost information used to prepare the estimate. ***Cost information*** is defined as the collection of information specifically used to prepare ***this*** estimate and may be based on the following (or other) sources: past projects; publications; software; data from personal files and/or networking; contracted studies (past or current); vendor information or quotes.

2.1 Completeness of cost information

Cost information that should be considered:

- labor rates ($/hr)
- equipment
- production rates/unit rates
- materials
- facility unit cost (e.g. $/bbl, $/SF, etc.)
- cost factors
- cost curves
- location adjustments
- time cost of money adjustments
- indirect/overhead costs

Suggested Rating Scale for Element 2.1:

How complete is the cost information used to prepare *this* estimate?

1. Almost all of the items listed above are addressed.
2. Most of items are addressed.
3. Some of the items are addressed.
4. Few of the items are addressed.
5. Almost none of the items are addressed

2.2 Applicability of cost information

The cost information used to prepare this estimate should be directly related to this project's needs, systems, processes, size, location, etc. (i.e. from similar projects).

Suggested Rating Scale for Element 2.2:

How applicable is the cost information to *this* estimate?

1. Almost all of the information applies.
2. Most of the information applies.
3. Some of the information applies.
4. Little of the information applies.
5. Almost none of the information applies.

2.3 Accuracy and reliability of cost information

Is the cost information:

- based on many data sources/data points or only a few?
- based on bids, quotes or budgetary estimates?
- updated to reflect current prices?
- statistically valid?
- verified through previous usage?
- based on actual historical costs?
- aligned with known market conditions/volatility?

Suggested Rating Scale for Element 2.3:

What is the overall level of accuracy and reliability of the cost information?

1. Very high
2. High
3. Moderate
4. Low
5. Very Low

2.4 Standard procedure for updating cost information

Is there a formal process in place and utilized for data collection to ensure the cost information is kept up-to-date?

Suggested Rating Scale for Element 2.4:

Standard procedure for collection of data (how do you collect your data?)

1. Standard procedure for routinely collecting data is followed rigidly
2. Standard procedure is followed most of the time
3. Standard procedure is followed some of the time
4. No standard procedure, data is collected the same for each estimate
5. No standard procedure, data is collected differently for each estimate

---

2.5 Time allowed for preparing the estimate

The following factors affect the amount of time required to adequately prepare an estimate:

- type of estimate
- intended use of estimate
- size/complexity of project
- availability of historical data and vendor support
- basis for estimate
- estimating plan
- stakeholder interfaces
- familiarity with scope
- changes after estimate basis was established

Suggested Rating Scale for Element 2.5:

Was *adequate* time allotted to prepare and review *this* estimate?

1. Sufficient to accommodate changing needs
2. Adequate with some slack
3. Adequate without slack
4. Marginal or rushed
5. Inadequate

2.6 Alignment of estimate methodology with available project information

The techniques used to develop the estimate should be commensurate with the level of project information available. For example, using a ratio or factored method to estimate a project where a significant amount of quantitative information is known is taking little or no advantage of the available project information (due to time limitations, etc.). Another example would be extensive use of allowances when specific information is known, or trying to be too quantitative when the project information does not support it, such as forming a detailed estimate with conceptual scope.

Suggested Rating Scale for Element 2.6:

Is there alignment between the estimate methodology and the available project information?

1. Excellent alignment
2. Good alignment
3. Fair alignment
4. Poor alignment
5. No alignment

2.7 Is the estimating work process formally defined and followed?

The estimating work process includes factors such as:

- plan for preparing estimate
- schedule for preparing estimate
- qualification of estimate (key information, basis, exclusions, etc.)
- standard code of accounts
- checklists
- kickoff team meeting
- planning schedule for project (milestones...)
- review procedure (project team, peer, management review)
- utilization of database/cost history

Suggested Rating Scale for Element 2.7:

How well was the estimating work process defined and followed in preparation of this estimate?

1. Defined and rigidly followed
2. Defined and generally followed
3. Defined and loosely followed
4. Vaguely defined and followed
5. Not defined or not followed

2.8 Formal structure to categorize and prepare the cost estimate

The quality and accuracy of an estimate is highly dependent on a standard format to categorize cost items during the preparation of the estimate.

Suggested Rating Scale for Element 2.8:

Was a standard format followed during the preparation of this estimate?

1. Defined and rigidly followed
2. Defined and generally followed
3. Defined and loosely followed
4. Vaguely defined and followed
5. Not defined or not followed

2.9 Utilization of check lists to ensure completeness and technical basis

Check lists are valuable in assuring the completeness and technical basis of the estimate.

Suggested Rating Scale for Element 2.9:

Were appropriate checklists used in the preparation of *this* estimate?

1. Check lists fully utilized
2. Extensive use
3. Some use
4. Little use
5. No check list used

2.10 Documentation of information used in preparing the estimate

Documentation of information used in the preparation of an estimate includes compilation of the following:

- parameters
- criteria
- scope of work
- supporting documents
- limitations
- exceptions
- assumptions
- project execution strategies

Suggested Rating Scale for Element 2.10:

Have these issues been documented for *this* estimate?

1. Almost all of the items documented
2. Most items documented
3. Some items documented
4. Few items documented
5. Almost none of the items documented

2.11 Method used to determine contingency

This element addresses the level of sophistication used to analyze risk and assign contingency to a project estimate. Although the Estimate Score system provides analysis on the base estimate only (with contingency removed from the analysis), an in-depth analysis of risk and contingency often requires greater attention to estimate specifics and can thus lead to a better base estimate.

Contingency is a real and necessary component of all cost estimates. Contingency can take the following forms:

1) Contingency for pricing uncertainty
2) Contingency for scope omissions and errors
3) Contingency for escalation uncertainty
4) Contingency for possible schedule changes
5) Contingency for possible scope expansion
6) Contingency for acts of God

Contingency items 1) through 3) usually are included in a conceptual cost estimate. Contingency item 4) may or may not be included depending upon management philosophy. Contingency item 5) may be included in an extremely preliminary estimate. Contingency item 6) is typically not included in an estimate.

Formal risk analysis techniques include:

- Monte Carlo simulation
- Statistical range analysis

Suggested Rating Scale for Element 2.11:

What is the level of risk analysis that was used in preparing this estimate?

1. Contingency applied based on a formal risk analysis
2. Contingency applied as percentages of major cost items
3. Subjective contingency based on personal past experience
4. Contingency applied as standard percentage of the total estimated cost
5. Budget based on estimate with no contingency and no risk analysis

Division 3 – What was Known about the Project?

Information or issues related to some of the elements in this division might not be completely defined at the time an early estimate is prepared. There may also be instances where some information or issues related to an element may be more significant and have more impact than others. For these situations, it is appropriate to select a score of 1 when essentially all of the important information or issues are known and included in the estimate. As such, a rating of 1 may be appropriate if an element does not specifically apply to the project (i.e. everything is known that *needs* to be known, even if "everything" means "nothing"). A score of 5 should be chosen when the significant information or issues are not known or not included in the estimate and none of the above conditions apply.

3.1 Capacities

The design output of a given specification product from the unit. Capacities are usually defined as:

- on-stream factors
- yield
- design rate
-

Suggested Rating Scale for Element 3.1:

To what extent has the capacities been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.2 Technology

The chemistry used to convert the raw materials supplied to the unit into the finished product. Proven technology has the least risk of change. Experimental technology has the greatest risk of change. Technology can be evaluated as design output of a given specification product from the unit. Technology is usually defined as:

- existing/proven
- duplication
- new
- experimental

Suggested Rating Scale for Element 3.2:

To what extent has the technology been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.3 Processes

Processes involve a specific sequence of steps to change the raw materials into the finished product. Proven processes have the least risk, while experimental processes have a potential for change. Processes are usually defined as:

- existing/proven
- duplication
- new
- experimental

Suggested Rating Scale for Element 3.3:

To what extent have the processes been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.4 Site location

Has the geographical location of the proposed project been defined? This involves an assessment of the relative strengths and weaknesses of alternate site locations. Evaluation of sites may address issues relative to different types of sites, such as global country, location, "inside the fence", or "inside the building. The site location should include items such as:

- general geographic location
- access to the targeted market area
- near sources of raw materials
- location availability and cost of skilled labor
- available utilities and existing facilities
- access, such as road, rail, marine, air, etc.
- construction access and feasibility

Suggested Rating Scale for Element 3.4:

To what extent has the site location been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.5 Plot plan

The plot plan will show the location of new work in relation to adjoining units. It should include items such as:

- plant grid system with coordinates
- unit limits
- gates and fences
- off-site facilities
- tank farms
- roads and access ways
- rail facilities
- green space
- buildings
- major pipe-racks
- laydown areas
- construction/fabrication areas

Suggested Rating Scale for Element 3.5:

To what extent has the plot plan been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.6 Utility sources and supply conditions

Has a list been made identifying availability/non-availability of site utilities needed to operate the unit with supply conditions of temperature, pressure and quality? Definition of utility sources should include items such as:

- potable water
- drinking water
- cooling water
- fire water
- electricity (voltage levels)
- sewers
- instrument air
- plant air
- gases
- steam
- condensate

Suggested Rating Scale for Element 3.6:

To what extent has the utility sources been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.7 Environmental assessment

Evaluation of the site by characteristics should define information, such as:

- location in an EPA air quality non-compliance zone
- location in a wet lands area
- environmental permits now in force
- location of nearest residential area
- ground water monitoring in place
- containment requirements
- existing environmental problems with the site
- past/present use of site

Suggested Rating Scale for Element 3.7:

To what extent has the environmental assessment been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.8 Process flow sheets

Process flow sheets are drawings that provide the process description of the unit. The sheets should define items such as:

- major equipment items
- flow of materials to and from the major equipment items
- primary control loops for the major equipment items
- sufficient information to allow sizing of all process lines

Suggested Rating Scale for Element 3.8:

To what extent have the process flow sheets been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.9 Mechanical equipment list

The mechanical equipment list should identify all mechanical equipment by tag number, in summary format, to support the project. The list should define items such as:

- existing sources
- new sources
- relative sizes
- weights
- location
- capacities
- materials
- power requirements
- flow diagrams
- design temperature and pressure
- insulation and painting requirements
- equipment related ladders and platforms

Suggested Rating Scale for Element 3.9:

To what extent has the mechanical equipment list been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.10 Heat and material balances

Heat balances are tables of heat input and output for major equipment items (including all heat exchangers) within the unit. Material balances are tables of material input and output for all equipment items within the unit. The documentation of these balances should include:

- special heat balance table for reaction systems
- information on the conditions (e.g. temperature and pressure)
- volumetric amount (GPM, ACFM, etc.)

Suggested Rating Scale for Element 3.10:

To what extent have heat and material balances been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.11 Piping and instrumentation diagrams (P&ID's)

The P&ID's are considered critical elements of the scope definition package of an industrial plant. Development of the P&ID's usually requires several iterations to obtain all of the necessary information from each discipline specialist. The P&ID's are often not completely defined in a project's scope definition package. The following list can be used as an aid in evaluating the current state of development of the P&ID's:

- equipment - (number, type, size, capacity, etc.)
- piping - sizes, specification, insulation, reducers, tie-ins designated, etc.
- valves - number, type and sizes for process & maintenance, etc.
- piping specialty items - identification of items, numbering of items, etc.
- utilities - main connections, remaining connections, overall distribution, etc.
- instrumentation - elements, loops, control panel, computer inputs, etc.
- safety systems - relief valves, failure mode of control valves, etc.
- special notations – sloped lines, startup and shutdown notes, etc.

Suggested Rating Scale for Element 3.11:

To what extent have the P&ID's been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.12 Project strategy

Has a project strategy been defined that supports the business plan in relation to the following items?

- cost
- schedule
- quality

Suggested Rating Scale for Element 3.12:

To what extent have the project strategy been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.13 Project design criteria

The project design criteria defines the requirements and guidelines that govern the design of the project. It should include items such as:

- level of design detail required
- climatic data at the project site
- codes and standards - local and national
- utilization of engineering standards - owner's, contractor's, mixed

Suggested Rating Scale for Element 3.13:

To what extent have the project design criteria been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

3.14 Project schedule

Has the project schedule been developed, analyzed and agreed upon by the major project participants? Is the schedule subject to change or "cast in stone"? Has input been received from operations, engineering and construction? Does the schedule integrate engineering, procurement and construction? The level of definition of the project schedule may define items such as:

- engineering and design
- procurement
- construction
- sequencing requirements
- outages
- startup and commissioning

Suggested Rating Scale for Element 3.14:

To what extent have the project schedule been defined for *this* project?

1. Clearly defined with no deficiencies
2. Defined with minor deficiencies
3. Defined with significant deficiencies
4. Major deficiencies or clarifications pending
5. Incompletely or poorly defined

Division 4 – Other Factors Affecting the Estimate

Information or issues related to some of the elements in this division might not be completely defined at the time an early estimate is prepared. There may also be instances where some information or issues related to an element may be more significant and have more impact than others. For these situations, it is appropriate to select a score of 1 when essentially all of the important information or issues are known and included in the estimate. As such, a rating of 1 may be appropriate if an element does not specifically apply to the project (i.e. everything is known that *needs* to be known, even if "everything" means "nothing"). In addition, a rating of 1 could apply if an element is specifically excluded from the estimate and NOT to be included in the accounting of actual costs (i.e. Owner's costs may fall into this category if the estimate is performed by an Engineer or Contractor). A score of 5 should be chosen when the significant information or issues are not known or not included in the estimate and none of the above conditions apply.

4.1 Owner's costs

To what extent have issues related to owner's costs been defined for this project? Consider the following:

- land
- permits
- equipment inspection
- start-up chemicals, catalysts, etc.
- testing, commissioning and start-up costs
- spares (start-up, operating, etc.)
- home office costs
- training
- on-site representation
- manufacturer's site visits

Suggested Rating Scale for Element 4.1:

To what extent have these issues been addressed in preparing *this* estimate?

1. Almost all issues addressed or specifically excluded from estimate
2. Most of the issues addressed
3. Some of the issues addressed
4. Few of the issues addressed
5. Almost none of the issues addressed

4.2 Impact of project classification

Examples of project classification include grassroots/greenfield, revamp, debottlenecking, demolition and remediation. Consider the following:

- interfaces with existing facilities
- restriction of access to construction area
- construction during non-normal working hours
- special security requirements
- shut-down availability with respect to plant operation schedule
- connection to existing systems in operation
- documentation of existing conditions (as-built drawings, etc.)
- unexpected changes in existing conditions (hidden conditions, such as underground piping, environmental problems, hazardous materials, soils)
- matching existing systems/components (valves, controls, pumps by vendor)
- noise abatement
- environmental assessment
- tie-in to local power and utility systems
- infrastructure requirements

Suggested Rating Scale for Element 4.2:

To what extent have these issues been addressed in preparing *this* estimate?

1. Almost all issues addressed
2. Most of the issues addressed
3. Some of the issues addressed
4. Few of the issues addressed
5. Almost none of the issues addressed

4.3 Impact of contract type

The impact of various types of contracts must be addressed from both the owner and contractor's viewpoint. The following issues should be addressed:

- contract type (design/build, design/bid/build, T&M, CM, partnering, etc.)
- pricing format (fixed price, cost reimbursable, GMP, etc.)
- damage clauses (consequential, liquidated damages, etc.)

Suggested Rating Scale for Element 4.3:

To what extent have these issues been addressed in preparing *this* estimate?

1. Almost all issues addressed
2. Most of the issues addressed
3. Some of the issues addressed
4. Few of the issues addressed
5. Almost none of the issues addressed

4.4 Impact of project schedule

Has an evaluation been made of the project schedule and its impact on the following contributors to project cost?

- equipment and material premiums
- productivity (design & construction)
- overheads/indirects
- rework/changes
- logistics
- overtime
- compressed schedule
- extended schedule
- integration with other schedules (existing operations, etc.)

Suggested Rating Scale for Element 4.4:

To what extent have these issues been addressed in preparing *this* estimate?

1. Almost all issues addressed
2. Most of the issues addressed
3. Some of the issues addressed
4. Few of the issues addressed
5. Almost none of the issues addressed

4.5 Impact of governmental requirements

Governmental issues that should be addressed in preparing the estimate include:

- environmental/permitting issues
- political/social environment at the proposed facility
- local composition of the project team? (joint venture partners)
- utilization of expatriate labor/management force
- Disadvantaged Business Enterprise (DBE)
- Minority Business Enterprise (MBE)
- Women Business Enterprise (WBE)
- requirements to buy local or foreign materials
- requirements to use local or foreign vendors/suppliers
- relationship of U. S. government with the government at proposed facility
- requirement of sponsorship fee required (agency fee for doing work)
- need for military protection at the project in foreign countries

Suggested Rating Scale for Element 4.5:

To what extent have these issues been addressed in preparing *this* estimate?

1. Almost all issues addressed
2. Most of the issues addressed
3. Some of the issues addressed
4. Few of the issues addressed
5. Almost none of the issues addressed

4.6 Work force

Work force issues that should be addressed in preparing the estimate include:

- union vs. nonunion
- direct hire vs. subcontract
- work rules
- labor rates
- craft labor mix
- fringe benefits

Suggested Rating Scale for Element 4.6:

To what extent have these issues been addressed in preparing *this* estimate?

1. Almost all issues addressed
2. Most of the issues addressed
3. Some of the issues addressed
4. Few of the issues addressed
5. Almost none of the issues addressed

4.7 Labor productivity

Labor productivity issues that should be addressed in preparing the estimate include:

- weather
- working height
- congestion/density
- environmental impacts/protective measures required
- proximity to existing facilities in operation
- overtime
- skill levels
- work rules
- cultural impacts

Suggested Rating Scale for Element 4.7:

To what extent have these issues been addressed in preparing *this* estimate?

1. Almost all issues addressed
2. Most of the issues addressed
3. Some of the issues addressed
4. Few of the issues addressed
5. Almost none of the issues addressed

4.8 Bidding climate

Bidding climate issues that should be addressed in preparing the estimate include:

- availability of general contractors
- availability of specific-trade contractors
- availability of vendors/suppliers
- availability of craft labor (imported labor requirements, travelers, etc.)
- other projects nearby during same time frame
- surrounding market conditions
- duration of assignment
- overtime or other incentives
- sole-source requirements

Suggested Rating Scale for Element 4.8:

To what extent have these issues been addressed in preparing *this* estimate?

1. Almost all issues addressed
2. Most of the issues addressed
3. Some of the issues addressed
4. Few of the issues addressed
5. Almost none of the issues addressed

4.9 Taxes and insurance

Tax and insurance issues that should be addressed in preparing the estimate include:

- tariffs, duties and customs
- time required to process through customs
- cost of duties (fee for bringing materials/equipment into the country)
- special restrictions, such as construction equipment must stay in (or be removed from) country when completed
- requirements for performance bonds (level and duration)
- required value added taxes (VAT)
- Has a level of coverage for insurance been established?

Suggested Rating Scale for Element 4.9:

To what extent have these issues been addressed in preparing *this* estimate?

1. Almost all issues addressed
2. Most of the issues addressed
3. Some of the issues addressed
4. Few of the issues addressed
5. Almost none of the issues addressed

4.10 Money factors

Money issues that should be addressed in preparing the estimate include:

- cost of money (e.g. interest during construction)
- currency exchange fluctuation
- financing arrangement requirements
- escalation (inflation)
- cash-flow constraints

Suggested Rating Scale for Element 4.10:

To what extent have these issues been addressed in preparing *this* estimate?

1. Almost all issues addressed
2. Most of the issues addressed
3. Some of the issues addressed
4. Few of the issues addressed
5. Almost none of the issues addressed

4.11 Logistics for engineering and construction

Issues that should be addressed in preparing the estimate include:

For Engineering:

- coordination of engineering
- compatibility of CADD software
- communications/distribution of documents to/from the U. S.
- the cost of assembling construction bid packages
- travel/lodging at the engineers offices
- communication link between the engineer and end vendor
- multiple engineering packages
- timing of distribution, review and approval of submittals

For Construction:

- schedule (is it impacted by logistics problems?)
- sequencing (special sequencing requirements)
- site accessibility
- port location, rail access, air freight into site
- accommodating existing facilities
- communications availability (telephone, satellite, fax,)
- procurement (local vendors vs. outside vendors)
- remoteness of site (construction camps, transportation)
- coordination with engineer/owner
- language considerations

Suggested Rating Scale for Element 4.11:

To what extent have these issues been addressed in preparing *this* estimate?

1. Almost all issues addressed
2. Most of the issues addressed
3. Some of the issues addressed
4. Few of the issues addressed
5. Almost none of the issues addressed

APPENDIX B

PROJECT DATA

Project ID	Estimated Total	Contingency	Base Estimate	Actual Total	% Cost Overrun	Discretionary Scope Changes	Project Type	Project Sub-Type
CII-131-28	$ 112,000,000	$ 4,307,692	$ 107,692,308	$ 113,400,000	5.3%	No	Industrial	Electrical (Generating)
CII-131-32	$ 3,200,000	$ 200,000	$ 3,000,000	$ 2,900,000	-3.3%	No	Industrial	Metals Refining/Processing
CII-131-35	$ 77,395,000	$ 10,095,000	$ 67,300,000	$ 74,960,000	11.4%	No	Industrial	Metals Refining/Processing
CII-131-42	$ 189,000,000	$ 15,000,000	$ 174,000,000	$ 160,515,000	-7.8%	No	Industrial	Oil Refining
CII-131-49	$ 9,922,000	$ 902,000	$ 9,020,000	$ 10,278,000	13.9%	No	Industrial	Other
CII-131-55	$ 25,225,000	$ 1,787,000	$ 23,438,000	$ 22,815,000	-2.7%	No	Industrial	Pulp and Paper
CII-131-63	$ 911,000	$ 82,819	$ 828,181	$ 1,116,000	34.8%	No	Other	Other
CII-131-01	$ 395,000	$ 35,000	$ 360,000	$ 470,000	30.6%	No	Industrial	Chemical Mfgr
CII-131-02	$ 900,000	$ 36,000	$ 864,000	$ 845,000	-2.2%	No	Industrial	Chemical Mfgr
CII-131-03	$ 1,100,000	$ 51,000	$ 1,049,000	$ 1,016,000	-3.1%	No	Industrial	Chemical Mfgr
CII-131-05	$ 1,750,000	$ 150,000	$ 1,600,000	$ 1,750,000	9.4%	No	Industrial	Chemical Mfgr
CII-131-08	$ 5,950,000	$ 166,000	$ 5,784,000	$ 6,141,000	6.2%	No	Industrial	Chemical Mfgr
CII-131-10	$ 12,000,000	$ 2,000,000	$ 10,000,000	$ 11,400,000	14.0%	No	Industrial	Chemical Mfgr
CII-131-11	$ 12,500,000	$ 1,500,000	$ 11,000,000	$ 13,300,000	20.9%	No	Industrial	Chemical Mfgr
CII-131-15	$ 40,000,000	$ 5,000,000	$ 35,000,000	$ 50,500,000	44.3%	No	Industrial	Chemical Mfgr
CII-131-16	$ 61,400,000	$ 6,100,000	$ 55,300,000	$ 51,300,000	-7.2%	No	Industrial	Chemical Mfgr
CII-131-18	$ 71,000,000	$ 2,754,000	$ 68,246,000	$ 68,300,000	0.1%	No	Industrial	Chemical Mfgr
CII-131-20	$ 183,400,000	$ 16,700,000	$ 166,700,000	$ 178,000,000	6.8%	No	Industrial	Chemical Mfgr
CII-131-24	$ 3,860,000	$ 200,000	$ 3,660,000	$ 4,190,000	14.5%	No	Industrial	Electrical (Generating)
CII-131-30	$ 536,300,000	$ 21,300,000	$ 515,000,000	$ 557,600,000	8.3%	No	Industrial	Electrical (Generating)
CII-131-38	$ 72,000,000	$ 4,000,000	$ 68,000,000	$ 73,500,000	8.1%	No	Industrial	Oil Refining
CII-131-40	$ 77,600,000	$ 11,900,000	$ 65,700,000	$ 83,400,000	26.9%	No	Industrial	Oil Refining
CII-131-41	$ 75,200,000	$ 4,000,000	$ 71,200,000	$ 94,000,000	32.0%	No	Industrial	Oil Refining
CII-131-43	$ 188,600,000	$ 25,400,000	$ 163,200,000	$ 180,800,000	10.8%	No	Industrial	Oil Refining
CII-131-47	$ 7,088,000	$ 864,000	$ 6,224,000	$ 7,088,000	13.9%	No	Industrial	Other
CII-131-50	$ 113,000,000	$ 11,000,000	$ 102,000,000	$ 120,000,000	17.6%	No	Industrial	Other
CII-131-53	$ 18,700,000	$ 1,100,000	$ 17,600,000	$ 16,800,000	-4.5%	No	Industrial	Pulp and Paper
CII-131-54	$ 23,100,000	$ 150,000	$ 22,950,000	$ 20,100,000	-12.4%	No	Industrial	Pulp and Paper
CII-131-56	$ 48,700,000	$ 1,700,000	$ 47,000,000	$ 50,400,000	7.2%	No	Industrial	Pulp and Paper
CII-131-57	$ 58,000,000	$ 7,650,000	$ 50,350,000	$ 55,800,000	10.8%	No	Industrial	Pulp and Paper
CII-131-58	$ 101,000,000	$ 5,400,000	$ 95,600,000	$ 100,700,000	5.3%	No	Industrial	Pulp and Paper
CII-131-61	$ 405,000,000	$ 32,000,000	$ 373,000,000	$ 375,000,000	0.5%	No	Industrial	Pulp and Paper
CII-131-12	$ 19,865,000	$ 926,000	$ 18,939,000	$ 21,750,600	14.8%	No	Industrial	Chemical Mfgr
CII-131-13	$ 24,645,000	$ 1,009,800	$ 23,635,200	$ 29,841,000	26.3%	No	Industrial	Chemical Mfgr
CII-131-14	$ 30,700,000	$ 3,188,000	$ 27,512,000	$ 30,560,000	11.1%	No	Industrial	Chemical Mfgr
CII-131-17	$ 64,700,000	$ 2,300,000	$ 62,400,000	$ 64,500,000	3.4%	No	Industrial	Chemical Mfgr
CII-131-21	$ 34,469,000	$ 1,768,000	$ 32,701,000	$ 36,536,000	11.7%	No	Industrial	Consumer Products Mfgr
CII-131-22	$ 970,000	$ 67,000	$ 903,000	$ 1,308,000	44.9%	No	Industrial	Electrical (Generating)
CII-131-27	$ 97,832,000	$ 3,762,769	$ 94,069,231	$ 99,500,000	5.8%	No	Industrial	Electrical (Generating)
CII-131-29	$ 150,000,000	$ 9,154,930	$ 140,845,070	$ 152,000,000	7.9%	No	Industrial	Electrical (Generating)
CII-131-36	$ 31,400,000	$ 2,960,000	$ 28,440,000	$ 28,510,000	0.2%	No	Industrial	Oil Refining
CII-131-37	$ 39,500,000	$ 2,800,000	$ 36,700,000	$ 44,600,000	21.5%	No	Industrial	Oil Refining
CII-131-39	$ 74,800,000	$ 4,900,000	$ 69,900,000	$ 82,000,000	17.3%	No	Industrial	Oil Refining
CII-131-44	$ 190,537,000	$ 12,847,000	$ 177,690,000	$ 219,302,000	23.4%	No	Industrial	Oil Refining
CII-131-48	$ 7,981,450	$ 303,840	$ 7,677,610	$ 9,012,000	17.4%	No	Industrial	Other
CII-131-51	$ 217,658,000	$ 11,786,000	$ 205,872,000	$ 239,042,000	16.1%	No	Industrial	Other
CII-131-62	$ 581,500,000	$ 37,579,000	$ 543,921,000	$ 589,069,000	8.3%	No	Industrial	Pulp and Paper
CII-131-65	$ 5,500,000	$ 661,000	$ 4,839,000	$ 5,400,000	11.6%	No	Other	Other
CII-131-04	$ 1,750,000	$ 147,000	$ 1,603,000	$ 1,750,000	9.2%	No	Industrial	Chemical Mfgr
CII-131-06	$ 3,400,000	$ 252,000	$ 3,148,000	$ 3,350,000	6.4%	No	Industrial	Chemical Mfgr
CII-131-09	$ 6,850,000	$ 1,661,000	$ 5,189,000	$ 6,645,000	28.1%	No	Industrial	Chemical Mfgr
CII-131-19	$ 150,000,000	$ 25,000,000	$ 125,000,000	$ 132,000,000	5.6%	No	Industrial	Chemical Mfgr
CII-131-23	$ 1,317,000	$ 63,000	$ 1,254,000	$ 1,361,000	8.5%	No	Industrial	Electrical (Generating)
CII-131-26	$ 7,547,000	$ 390,000	$ 7,157,000	$ 7,049,000	-1.5%	No	Industrial	Electrical (Generating)
CII-131-31	$ 3,000,000	$ 435,970	$ 2,564,030	$ 3,401,377	32.7%	No	Industrial	Environmental
CII-131-33	$ 21,360,802	$ -	$ 21,360,802	$ 22,402,871	4.9%	No	Industrial	Metals Refining/Processing
CII-131-46	$ 1,100,000	$ 104,000	$ 996,000	$ 900,000	-9.6%	No	Industrial	Other
CII-131-52	$ 15,000,000	$ 1,899,563	$ 13,100,437	$ 15,300,000	16.8%	No	Industrial	Pharmaceuticals Mfgr
CII-131-59	$ 115,000,000	$ 8,050,000	$ 106,950,000	$ 107,062,000	0.1%	No	Industrial	Pulp and Paper
CII-131-60	$ 201,600,000	$ 13,000,000	$ 188,600,000	$ 188,442,000	-0.1%	No	Industrial	Pulp and Paper
CII-131-64	$ 2,671,000	$ 241,987	$ 2,429,013	$ 3,525,488	45.1%	No	Other	Other
CII-131-07	$ 4,040,700	$ 241,200	$ 3,799,500	$ 3,888,335	2.3%	No	Industrial	Chemical Mfgr
CII-131-25	$ 5,630,000	$ 313,000	$ 5,317,000	$ 5,915,000	11.2%	No	Industrial	Electrical (Generating)
CII-131-34	$ 57,000,000	$ 5,000,000	$ 52,000,000	$ 60,300,000	16.0%	No	Industrial	Metals Refining/Processing
CII-131-45	$ 738,911,600	$ 38,513,000	$ 700,398,600	$ 810,387,000	15.7%	No	Industrial	Oil Refining
CII-131-66	$ 13,300,000	$ -	$ 13,300,000	$ 13,600,000	2.3%	No	Other	Other
CII-131-67	$ 19,990,000	$ 2,000,000	$ 17,990,000	$ 20,235,088	12.5%	No	Other	Other
CII-131-68	$ 68,000,000	$ 2,000,000	$ 66,000,000	$ 72,000,000	9.1%	Yes	Building	Laboratory
CII-131-69	$ 654,000	N/A	N/A	$ 617,300	N/A	No	Building	Other
CII-131-70	$ 2,415,000	$ 115,000	$ 2,300,000	$ 2,245,029	-2.4%	Yes	Building	Other
CII-131-71	$ 2,504,700	N/A	N/A	$ 2,339,380	N/A	No	Building	Other
CII-131-72	$ 4,063,000	N/A	N/A	$ 3,869,167	N/A	No	Building	Other
CII-131-73	$ 3,171,000	$ 151,000	$ 3,020,000	$ 4,310,688	42.7%	Yes	Building	Other
CII-131-74	$ 4,662,000	$ 222,000	$ 4,440,000	$ 4,317,587	-2.8%	Yes	Building	Other
CII-131-75	$ 4,919,250	$ 234,250	$ 4,685,000	$ 5,146,100	9.8%	Yes	Building	Other
CII-131-76	$ 9,000,000	N/A	N/A	$ 8,700,000	N/A	No	Building	Other
CII-131-77	$ 12,100,000	N/A	N/A	$ 11,200,000	N/A	No	Building	Other
CII-131-78	$ 27,751,500	$ 1,321,500	$ 26,430,000	$ 31,792,500	20.3%	Yes	Building	Other
CII-131-79	$ 13,360,000	N/A	N/A	$ 11,994,026	N/A	No	Industrial	Chemical Mfgr
CII-131-80	$ 11,300,000	$ 600,000	$ 10,700,000	$ 12,300,000	15.0%	Yes	Industrial	Chemical Mfgr
CII-131-81	$ 15,695,400	N/A	N/A	$ 14,275,259	N/A	No	Industrial	Chemical Mfgr
CII-131-82	$ 97,000,000	N/A	N/A	$ 110,000,000	N/A	No	Industrial	Chemical Mfgr
CII-131-83	$ 3,000,000	$ 440,000	$ 2,560,000	$ 1,980,000	-22.7%	Yes	Industrial	Electrical (Generating)
CII-131-84	$ 1,750,000	$ 200,000	$ 1,550,000	$ 2,110,000	36.1%	Yes	Industrial	Electrical (Generating)
CII-131-85	$ 2,073,000	$ 187,000	$ 1,886,000	$ 1,494,000	-20.8%	Yes	Industrial	Oil Refining
CII-131-86	$ 214,193,700	$ 24,739,000	$ 189,454,700	$ 148,266,800	-21.7%	Yes	Industrial	Oil Refining
CII-131-87	$ 13,347,000	$ 3,578,000	$ 9,769,000	$ 20,138,000	106.1%	Yes	Industrial	Other
CII-131-88	$ 7,520,000	N/A	N/A	$ 8,010,000	N/A	No	Industrial	Pulp and Paper
CII-131-89	$ 14,000,000	N/A	N/A	$ 12,800,000	N/A	No	Other	Other

Project ID	Project Classification	1_1	1_2	1_3	1_4	1_5	1_6	1_7	1_8	1_9	2_1	2_2	2_3	2_4	2_5
CII-131-28	Add-On	3	1	1	1	4	4	2	1	2	3	1	2	2	2
CII-131-32	Add-On	4	2	1	2	3	2	3	4	3	2	4	2	3	2
CII-131-35	Add-On	1	2	2	1	2	3	2	1	2	2	2	3	4	4
CII-131-42	Add-On	2	1	2	1	3	1	1	1	2	1	2	2	1	2
CII-131-49	Add-On	2	3	2	2	3	3	3	2	3	3	3	3	2	4
CII-131-55	Add-On	4	3	3	2	4	3	3	1	2	1	2	2	2	2
CII-131-63	Add-On	3	3	2	2	4	3	4	2	4	4	3	3	3	2
CII-131-01	Conversion	2	2	2	3	2	3	2	2	4	2	2	2	3	4
CII-131-02	Conversion	2	2	2	3	2	2	2	3	4	2	3	2	4	4
CII-131-03	Conversion	2	2	2	3	2	2	3	2	3	2	2	2	3	3
CII-131-05	Conversion	2	2	3	2	2	2	2	2	4	2	2	2	3	2
CII-131-08	Conversion	2	2	2	3	2	2	2	3	4	2	3	2	4	4
CII-131-10	Conversion	3	1	3	2	1	2	1	2	2	3	3	3	2	3
CII-131-11	Conversion	3	3	4	2	3	2	3	2	2	3	4	3	3	3
CII-131-15	Conversion	3	4	3	3	3	3	3	3	3	4	3	3	2	4
CII-131-16	Conversion	2	1	1	2	2	1	2	2	2	2	2	2	1	3
CII-131-18	Conversion	2	1	1	1	2	2	1	1	1	2	2	2	2	2
CII-131-20	Conversion	1	1	1	2	2	1	2	1	2	2	2	2	1	3
CII-131-24	Conversion	2	2	2	1	2	2	3	1	3	2	3	2	2	3
CII-131-30	Conversion	2	1	1	1	1	1	2	1	2	1	1	1	1	2
CII-131-38	Conversion	4	1	1	2	1	1	1	1	2	2	2	2	2	3
CII-131-40	Conversion	2	3	1	4	5	3	4	3	4	2	2	3	4	4
CII-131-41	Conversion	2	1	2	2	3	2	3	2	3	2	2	2	2	3
CII-131-43	Conversion	1	1	2	2	2	1	2	1	2	2	2	2	1	2
CII-131-47	Conversion	2	3	4	2	3	2	3	2	3	3	3	3	2	1
CII-131-50	Conversion	2	3	2	2	3	2	5	2	5	4	3	3	4	3
CII-131-53	Conversion	3	3	2	1	2	2	3	2	3	2	2	3	3	1
CII-131-54	Conversion	2	2	1	1	1	1	2	2	2	1	1	1	1	1
CII-131-56	Conversion	2	2	3	4	3	2	2	2	2	1	1	2	1	1
CII-131-57	Conversion	2	2	1	1	2	3	2	1	1	1	3	2	3	2
CII-131-58	Conversion	3	2	2	4	3	4	3	1	3	3	2	2	2	2
CII-131-61	Conversion	2	3	2	2	2	3	3	2	4	2	2	2	5	2
CII-131-12	Grass Roots	3	2	2	1	3	2	2	1	2	3	3	3	3	4
CII-131-13	Grass Roots	4	1	2	1	3	2	4	1	3	2	2	2	2	4
CII-131-14	Grass Roots	3	2	1	1	2	1	2	1	1	1	1	2	1	2
CII-131-17	Grass Roots	1	1	1	1	5	1	1	1	3	1	1	1	2	2
CII-131-21	Grass Roots	2	1	3	4	3	3	3	3	3	4	2	4	4	2
CII-131-22	Grass Roots	3	3	3	2	4	4	5	2	4	2	3	3	3	5
CII-131-27	Grass Roots	5	5	3	5	4	4	3	4	2	3	3	4	5	2
CII-131-29	Grass Roots	4	5	3	1	4	1	3	4	3	1	3	2	2	2
CII-131-36	Grass Roots	1	2	1	1	2	1	1	1	4	1	1	2	3	2
CII-131-37	Grass Roots	2	1	1	1	2	2	3	1	3	1	1	2	2	2
CII-131-39	Grass Roots	1	2	2	1	3	2	4	2	2	2	2	2	3	2
CII-131-44	Grass Roots	3	2	1	2	2	1	3	1	3	2	2	3	3	2
CII-131-48	Grass Roots	2	3	2	2	3	3	3	2	3	3	3	3	2	4
CII-131-51	Grass Roots	2	3	3	2	2	2	2	1	3	2	1	3	2	2
CII-131-62	Grass Roots	3	2	2	2	2	2	3	1	3	2	2	2	1	2
CII-131-65	Grass Roots	2	2	3	2	2	1	3	1	3	1	2	3	1	2
CII-131-04	Modernization	2	2	3	1	3	1	2	2	3	2	2	2	4	2
CII-131-06	Modernization	1	2	3	2	3	1	3	1	3	2	2	3	4	2
CII-131-09	Modernization	2	4	2	1	4	1	3	2	3	3	2	3	2	4
CII-131-19	Modernization	2	2	1	2	1	1	2	2	2	1	1	2	1	1
CII-131-23	Modernization	2	2	2	2	2	2	2	2	2	3	3	3	4	4
CII-131-26	Modernization	2	2	1	1	2	2	3	2	2	2	2	2	3	4
CII-131-31	Modernization	3	3	2	1	3	3	3	1	3	1	2	2	2	2
CII-131-33	Modernization	2	3	2	3	2	2	3	3	3	3	2	3	3	3
CII-131-46	Modernization	1	1	1	1	1	1	2	1	1	1	1	1	1	1
CII-131-52	Modernization	1	2	2	1	3	4	3	2	3	1	1	2	2	4
CII-131-59	Modernization	2	3	2	1	3	3	3	2	3	3	3	3	4	2
CII-131-60	Modernization	2	2	2	1	2	2	1	1	3	2	2	2	2	2
CII-131-64	Modernization	3	3	2	2	4	3	4	2	4	4	3	3	3	2
CII-131-07	Other	1	2	2	1	1	1	1	1	2	1	1	2	1	2
CII-131-25	Other	3	2	2	1	2	2	3	2	2	3	3	3	4	4
CII-131-34	Other	4	1	1	3	4	3	5	1	2	3	2	2	4	3
CII-131-45	Other	2	2	2	2	2	1	4	1	4	3	3	3	2	4
CII-131-66	Other	4	2	2	1	3	1	3	1	4	1	2	3	3	4
CII-131-67	Other	4	3	2	2	2	1	3	2	1	2	2	2	4	3
CII-131-68	Add-On	3	2	2	2	3	1	2	2	1	2	1	2	3	2
CII-131-69	Conversion	2	1	1	2	2	2	2	1	2	2	2	2	2	2
CII-131-70	Conversion	1	1	1	1	1	1	1	1	1	1	1	1	1	2
CII-131-71	Conversion	2	1	1	2	2	2	2	2	2	2	2	2	2	2
CII-131-72	Conversion	2	1	1	2	2	2	2	1	2	2	2	2	2	2
CII-131-73	Conversion	1	1	1	1	1	1	1	2	0	1	1	2	0	1
CII-131-74	Conversion	1	1	1	2	3	3	1	2	1	2	2	1	1	2
CII-131-75	Conversion	3	1	1	1	2	1	2	1	3	2	2	2	2	1
CII-131-76	Conversion	0	2	3	1	2	2	2	2	3	2	3	3	2	2
CII-131-77	Conversion	0	3	1	1	2	2	2	2	3	2	1	2	2	2
CII-131-78	Conversion	5	2	2	1	0	1	2	1	3	2	2	2	2	4
CII-131-79	Conversion	1	1	1	2	2	2	2	2	2	2	2	2	2	2
CII-131-80	Conversion	2	4	2	2	3	2	3	3	4	2	2	3	1	2
CII-131-81	Conversion	1	1	1	2	2	2	2	2	2	2	2	2	2	2
CII-131-82	Modernization	4	2	3	5	4	4	3	4	4	1	1	1	4	4
CII-131-83	Conversion	1	2	2	1	3	3	2	3	2	4	2	3	2	4
CII-131-84	Conversion	1	2	2	1	2	2	2	1	2	1	2	2	2	3
CII-131-85	Conversion	1	2	2	1	2	1	2	1	2	1	1	2	2	1
CII-131-86	Grass Roots	2	2	1	2	3	1	2	1	3	2	2	3	3	2
CII-131-87	Grass Roots	2	2	4	1	4	3	3	2	4	2	3	3	3	2
CII-131-88	Grass Roots	2	3	2	4	3	4	4	2	3	3	3	5	5	4
CII-131-89	Other	2	2	2	1	2	2	1	1	2	2	1	2	2	1

Project ID	2_6	2_7	2_8	2_9	2_10	2_11	3_1	3_2	3_3	3_4	3_5	3_6	3_7	3_8	3_9	3_10	3_11
CII-131-28	2	3	2	5	2	5	2	3	3	3	3	4	4	1	2	1	2
CII-131-32	5	3	2	2	4	3	1	1	4	1	4	3	3	1	2	1	1
CII-131-35	3	3	3	3	2	2	2	1	3	1	1	1	1	1	2	1	2
CII-131-42	1	1	1	2	1	1	1	1	2	2	2	2	2	1	2	1	2
CII-131-49	2	2	2	2	2	4	2	1	1	5	3	3	4	4	3	4	5
CII-131-55	2	2	2	3	2	2	2	2	3	1	2	3	1	2	2	3	3
CII-131-63	3	2	3	5	3	4	3	1	1	1	4	4	4	4	4	4	5
CII-131-01	2	4	3	5	2	1	1	1	1	1	1	1	4	1	1	1	2
CII-131-02	2	4	2	4	2	2	2	4	2	1	1	2	4	1	2	2	2
CII-131-03	2	2	2	4	2	3	1	1	1	1	1	2	2	1	1	1	1
CII-131-05	2	3	2	4	1	1	1	1	1	1	2	2	2	2	2	2	2
CII-131-08	2	4	2	4	1	1	2	4	2	1	1	2	4	1	2	2	2
CII-131-10	2	1	2	2	2	2	1	1	1	1	1	1	1	1	1	2	5
CII-131-11	2	3	3	5	4	2	4	3	3	2	2	3	3	4	4	3	4
CII-131-15	2	2	2	2	2	3	2	2	2	2	2	2	2	3	3	2	5
CII-131-16	2	1	1	2	1	1	1	1	1	1	2	1	2	1	2	1	1
CII-131-18	1	1	1	1	1	2	1	4	1	1	2	1	1	1	2	3	2
CII-131-20	2	1	1	2	2	1	2	1	1	2	2	2	1	1	2	1	1
CII-131-24	2	2	2	3	2	3	1	2	2	1	2	2	2	2	2	2	2
CII-131-30	2	1	1	2	1	1	2	1	1	2	1	1	2	1	1	1	1
CII-131-38	2	2	2	3	2	2	1	1	1	2	1	2	2	2	2	2	2
CII-131-40	2	4	2	5	4	3	3	1	1	1	4	3	4	3	5	5	5
CII-131-41	2	2	2	1	2	4	2	2	2	3	3	2	3	2	2	2	3
CII-131-43	2	1	1	2	2	1	2	2	2	1	2	2	2	1	1	1	2
CII-131-47	2	2	1	2	1	1	1	2	2	1	1	2	2	2	1	1	2
CII-131-50	2	2	2	2	2	2	2	3	2	1	3	5	4	1	1	1	2
CII-131-53	2	3	2	3	1	1	1	2	2	1	2	2	1	2	2	1	1
CII-131-54	1	1	2	3	1	3	1	1	2	1	2	1	1	1	2	1	2
CII-131-56	2	2	2	2	1	3	1	1	1	1	1	1	1	2	2	2	2
CII-131-57	1	1	1	2	1	1	1	3	4	3	1	2	1	1	1	2	1
CII-131-58	1	2	3	1	2	4	2	2	2	1	1	2	2	2	2	2	2
CII-131-61	2	4	3	3	3	4	2	1	1	1	1	1	2	1	1	2	1
CII-131-12	3	4	1	4	2	2	2	2	2	1	1	2	2	2	2	2	2
CII-131-13	2	1	1	2	1	5	1	2	2	1	1	3	2	2	1	2	5
CII-131-14	2	1	1	1	1	1	1	1	1	1	1	1	1	3	1	2	1
CII-131-17	2	1	1	2	1	1	1	2	1	1	1	1	2	1	1	1	2
CII-131-21	3	3	4	4	5	2	1	1	1	1	2	2	1	2	4	1	5
CII-131-22	4	3	2	3	3	2	4	3	1	2	2	3	1	4	3	3	3
CII-131-27	4	4	4	5	5	5	1	1	1	1	1	2	2	1	1	1	5
CII-131-29	1	1	3	4	2	2	3	4	1	1	2	5	1	2	3	3	3
CII-131-36	1	2	2	3	1	1	1	1	2	2	2	1	1	2	2	2	1
CII-131-37	1	2	2	2	1	1	1	1	1	1	1	1	1	1	2	1	2
CII-131-39	2	4	2	4	4	1	1	2	3	1	4	2	2	2	1	1	3
CII-131-44	1	2	1	3	1	1	1	1	1	1	2	1	1	1	2	1	3
CII-131-48	2	2	2	2	2	4	2	1	1	1	3	3	3	3	3	3	4
CII-131-51	2	2	1	3	2	4	1	1	2	1	1	2	1	3	2	2	3
CII-131-62	2	2	2	3	2	2	2	2	3	1	2	3	3	3	3	3	3
CII-131-65	2	2	1	2	2	1	2	2	1	3	1	3	2	1	1	1	2
CII-131-04	2	3	1	3	3	1	1	1	1	1	1	1	2	3	2	3	2
CII-131-06	2	2	1	3	2	2	1	1	1	1	3	2	2	2	2	2	2
CII-131-09	2	3	3	4	2	1	2	1	1	1	2	3	3	4	2	1	4
CII-131-19	1	1	1	2	1	1	1	4	4	1	1	1	1	1	4	1	4
CII-131-23	2	1	3	2	2	2	3	4	3	1	2	4	2	2	4	1	3
CII-131-26	2	3	2	3	2	2	2	2	3	1	2	2	1	3	3	2	2
CII-131-31	2	2	2	3	2	2	1	2	2	1	2	2	2	1	2	1	3
CII-131-33	4	3	2	2	3	3	2	2	2	2	2	3	1	2	3	2	5
CII-131-46	1	1	1	2	1	4	1	1	1	1	1	2	1	2	1	3	2
CII-131-52	2	2	2	3	2	4	2	2	4	1	1	2	1	3	1	4	3
CII-131-59	2	2	2	3	2	2	3	2	2	1	3	3	3	2	3	3	3
CII-131-60	2	2	2	3	2	2	2	3	3	1	2	3	3	2	2	2	2
CII-131-64	3	2	3	5	3	4	3	1	1	5	4	4	4	5	4	4	5
CII-131-07	2	1	1	1	1	2	2	1	1	1	2	2	2	2	1	2	4
CII-131-25	2	1	2	3	2	2	3	3	3	1	2	2	2	4	4	4	5
CII-131-34	2	3	2	4	2	3	3	1	1	1	2	3	1	2	3	3	2
CII-131-45	1	2	2	3	2	2	2	1	1	1	3	3	3	1	3	1	4
CII-131-66	2	2	1	3	1	1	1	1	2	1	2	2	1	2	2	2	4
CII-131-67	3	2	2	4	2	3	1	3	1	1	2	1	3	1	2	1	3
CII-131-68	3	2	2	2	2	4	1	2	1	2	3	2	3	1	2	1	1
CII-131-69	1	2	1	2	2	0	1	0	0	1	1	1	1	0	2	2	2
CII-131-70	1	1	1	2	1	1	1	1	1	1	1	1	1	0	1	1	0
CII-131-71	2	1	1	2	2	0	2	2	2	2	2	2	2	0	2	2	2
CII-131-72	1	1	1	2	2	0	2	2	2	2	2	1	2	0	2	2	2
CII-131-73	0	1	0	0	0	1	1	2	3	1	1	1	1	0	2	1	0
CII-131-74	2	3	3	2	2	2	2	3	2	2	1	4	4	1	4	1	1
CII-131-75	1	1	1	2	1	1	1	2	2	1	1	1	1	1	2	1	1
CII-131-76	3	2	2	3	1	3	2	2	2	2	2	2	2	2	2	3	2
CII-131-77	2	2	2	3	2	3	2	2	2	2	2	2	2	2	2	2	2
CII-131-78	2	1	1	2	2	1	4	0	4	1	1	2	2	0	3	2	0
CII-131-79	2	1	1	2	2	0	2	2	0	2	2	2	2	0	2	2	2
CII-131-80	2	2	3	3	2	3	2	2	3	1	1	2	1	2	2	2	2
CII-131-81	2	1	1	2	2	0	1	2	0	2	2	2	2	0	2	2	2
CII-131-82	3	2	1	3	3	1	4	1	1	2	2	2	1	1	2	1	2
CII-131-83	3	3	3	4	4	4	1	2	1	1	1	2	2	1	2	2	1
CII-131-84	2	2	2	3	3	3	1	2	1	1	1	2	2	1	2	2	1
CII-131-85	1	2	1	3	1	3	1	1	1	1	2	1	0	1	2	2	3
CII-131-86	1	2	1	3	1	2	1	1	1	1	2	2	3	1	2	1	3
CII-131-87	2	2	2	4	3	1	1	1	1	2	1	1	2	2	2	2	3
CII-131-88	4	4	4	3	3	4	2	0	2	2	2	1	2	2	2	1	2
CII-131-89	1	2	2	3	2	4	1	3	3	1	1	2	1	1	2	1	3

Project ID	3_12	3_13	3_14	4_1	4_2	4_3	4_4	4_5	4_6	4_7	4_8	4_9	4_10	4_11
CII-131-28	3	5	3	3	2	1	1	2	2	3	2	2	5	1
CII-131-32	3	3	1	1	2	1	1	1	2	3	3	1	1	4
CII-131-35	2	2	1	1	1	1	2	1	2	2	2	1	2	2
CII-131-42	2	2	2	1	1	1	1	1	1	1	1	1	1	1
CII-131-49	3	3	5	4	2	3	4	2	3	3	3	3	2	3
CII-131-55	4	3	2	2	2	3	4	3	2	4	4	2	2	3
CII-131-63	3	4	3	2	3	3	3	2	3	2	2	2	1	2
CII-131-01	4	4	5	2	2	4	4	3	3	5	5	2	2	2
CII-131-02	5	2	2	2	2	2	4	4	3	3	5	2	3	2
CII-131-03	1	1	1	1	2	4	1	4	2	2	3	4	2	2
CII-131-05	1	1	1	1	1	2	2	2	3	5	3	2	2	2
CII-131-08	5	2	2	2	2	2	4	4	3	3	5	1	3	2
CII-131-10	2	2	1	1	2	1	1	2	2	2	1	1	1	1
CII-131-11	2	4	4	1	3	1	3	1	3	3	1	1	1	3
CII-131-15	3	3	2	2	2	1	1	2	2	2	1	1	2	2
CII-131-16	2	2	1	1	2	1	1	1	1	1	1	1	1	1
CII-131-18	2	2	2	1	2	2	1	1	2	2	2	2	2	1
CII-131-20	2	2	2	1	2	2	1	2	1	2	1	1	1	2
CII-131-24	1	1	2	2	2	2	1	2	2	2	2	2	3	2
CII-131-30	2	2	1	1	1	1	1	1	1	1	1	1	1	2
CII-131-38	1	1	1	2	1	1	1	2	1	2	1	1	2	2
CII-131-40	5	3	5	2	3	4	4	4	2	2	3	4	2	4
CII-131-41	3	3	2	2	3	3	3	3	2	2	3	3	3	2
CII-131-43	2	2	2	1	2	2	2	2	2	2	2	1	1	1
CII-131-47	1	2	1	2	2	2	2	2	3	3	2	1	2	2
CII-131-50	3	5	3	2	2	4	3	5	4	4	4	4	3	4
CII-131-53	2	2	2	1	2	2	3	2	1	1	2	2	2	2
CII-131-54	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CII-131-56	1	2	2	2	2	1	1	1	2	2	1	1	1	1
CII-131-57	2	1	1	1	1	1	2	2	2	2	2	1	2	1
CII-131-58	3	2	2	3	2	3	2	1	1	2	2	1	1	2
CII-131-61	2	3	3	4	3	2	3	2	1	2	2	3	3	2
CII-131-12	2	2	1	5	3	3	3	1	4	4	5	1	2	2
CII-131-13	1	3	2	2	1	1	1	3	2	3	3	1	1	2
CII-131-14	1	1	2	2	1	3	2	1	1	1	1	2	2	1
CII-131-17	1	2	1	5	1	1	1	1	1	1	1	3	1	1
CII-131-21	1	1	1	1	3	3	2	3	3	3	4	2	3	3
CII-131-22	3	3	5	3	3	1	3	1	1	3	2	1	1	2
CII-131-27	4	2	2	2	3	1	5	5	5	5	5	2	5	5
CII-131-29	3	2	2	1	1	1	1	1	1	2	1	1	1	2
CII-131-36	1	1	2	1	1	3	1	1	1	1	1	1	1	1
CII-131-37	1	1	4	2	1	1	3	1	2	3	2	1	1	2
CII-131-39	3	3	3	1	1	3	4	2	2	3	4	1	1	2
CII-131-44	1	1	3	2	1	1	3	3	1	2	3	1	3	3
CII-131-48	3	3	5	4	2	3	4	2	3	3	3	3	2	3
CII-131-51	5	2	3	1	1	1	2	1	2	1	3	1	2	2
CII-131-62	4	3	2	2	2	1	2	3	2	2	3	3	2	2
CII-131-65	1	2	3	2	2	3	2	2	3	3	2	2	2	3
CII-131-04	2	2	1	2	1	1	2	2	3	3	2	1	1	1
CII-131-06	2	2	1	2	2	3	2	2	2	3	2	2	3	2
CII-131-09	2	2	2	3	3	3	5	4	2	2	4	1	1	3
CII-131-19	3	1	2	1	1	1	1	1	1	2	2	1	1	1
CII-131-23	4	4	5	1	2	1	2	2	2	2	1	1	1	2
CII-131-26	3	2	2	2	1	1	2	1	1	2	2	1	1	1
CII-131-31	1	1	2	1	2	1	2	2	1	2	1	2	2	2
CII-131-33	2	2	2	3	2	2	2	1	1	2	3	2	1	2
CII-131-46	1	2	3	1	1	1	1	1	1	1	1	1	1	1
CII-131-52	2	3	4	1	1	1	2	2	3	2	4	2	2	2
CII-131-59	3	2	2	2	2	1	2	3	2	3	2	2	2	2
CII-131-60	3	2	2	2	2	1	2	2	3	3	2	2	2	2
CII-131-64	3	5	5	2	3	3	3	2	3	2	2	2	1	2
CII-131-07	2	2	2	1	2	1	3	1	1	3	2	1	1	2
CII-131-25	2	3	2	1	2	1	2	2	2	2	1	1	1	2
CII-131-34	4	4	1	1	4	3	2	2	1	2	3	1	1	3
CII-131-45	1	4	3	3	2	1	4	3	3	2	3	2	3	3
CII-131-66	1	3	2	1	1	1	1	3	2	2	1	3	2	1
CII-131-67	3	3	2	1	2	1	1	5	2	1	2	3	1	2
CII-131-68	1	2	2	1	2	1	4	1	2	3	1	1	1	1
CII-131-69	0	1	2	1	1	1	2	1	1	1	1	1	0	1
CII-131-70	1	1	1	1	1	1	1	1	1	1	1	2	1	0
CII-131-71	2	1	2	1	2	2	2	2	2	2	2	2	0	2
CII-131-72	2	1	2	2	2	2	2	2	2	2	2	2	0	2
CII-131-73	1	1	2	1	3	2	2	1	1	1	3	1	0	0
CII-131-74	2	3	2	2	3	3	1	1	3	3	1	1	1	1
CII-131-75	5	2	3	1	1	4	4	1	2	2	5	1	1	1
CII-131-76	2	2	2	2	2	2	2	2	2	2	2	2	3	2
CII-131-77	2	2	2	1	1	1	1	2	1	1	2	2	2	2
CII-131-78	1	3	1	1	2	2	3	1	2	2	2	1	2	0
CII-131-79	2	2	2	1	2	2	2	2	2	2	2	2	0	2
CII-131-80	2	3	2	3	1	2	1	2	2	2	2	2	2	2
CII-131-81	2	2	2	1	2	2	2	2	2	2	2	2	0	2
CII-131-82	4	3	2	5	3	1	3	1	1	3	3	1	2	3
CII-131-83	1	2	1	2	2	1	1	1	1	4	2	2	3	2
CII-131-84	1	1	1	2	2	1	2	1	1	2	2	2	3	1
CII-131-85	2	1	1	1	2	1	2	3	1	1	2	2	1	1
CII-131-86	2	2	3	1	1	1	3	3	1	2	3	1	3	2
CII-131-87	1	3	4	3	2	1	3	2	1	2	2	3	2	2
CII-131-88	1	3	2	2	4	1	2	2	3	4	3	2	3	3
CII-131-89	1	1	2	1	2	1	1	3	2	2	2	2	3	2

APPENDIX C

SAS PROGRAM

```
dm 'log; clear; output; clear; ' ;
options ls=66 ps=44 pageno=1 nodate;

title;
filename file1 'd:\cii\dataanalysis\sas\projects.dbf';

title 'Improving Early Estimates, CII Research Team #131';

proc dbf db3=file1 out=one;

proc sort data=one;
   by p_name;

proc factor data=one method=prin nfactors=11
      rotate=varimax re out=fscores;
   var ES_1_1 -- ES_4_11;

proc reg data=fscores;
   model cost_ovr = factor1 -- factor11 /selection=maxr;

proc model;
  cost_ovr = b1;
   fit cost_ovr;

proc model;
   cost_ovr = b1 + b2*factor2 + b3*factor3 + b4*factor4
      + b5*factor5 + b6*factor10;
   fit cost_ovr;

run;
```

APPENDIX D

SAS OUTPUT

Initial Factor Method: Principal Components

Prior Communality Estimates: ONE

Eigenvalues of the Correlation Matrix: Total = 45 Average = 1

	1	2	3	4
Eigenvalue	12.7888	4.1335	2.8163	2.2552
Difference	8.6553	1.3172	0.5611	0.4398
Proportion	0.2842	0.0919	0.0626	0.0501
Cumulative	0.2842	0.3761	0.4386	0.4888

	5	6	7	8
Eigenvalue	1.8154	1.6818	1.6453	1.4006
Difference	0.1336	0.0365	0.2447	0.0970
Proportion	0.0403	0.0374	0.0366	0.0311
Cumulative	0.5291	0.5665	0.6030	0.6342

	9	10	11	12
Eigenvalue	1.3036	1.2204	1.1156	1.1035
Difference	0.0832	0.1048	0.0121	0.0934
Proportion	0.0290	0.0271	0.0248	0.0245
Cumulative	0.6631	0.6902	0.7150	0.7396

	13	14	15	16
Eigenvalue	1.0101	0.9930	0.9089	0.8739
Difference	0.0170	0.0842	0.0350	0.1232
Proportion	0.0224	0.0221	0.0202	0.0194
Cumulative	0.7620	0.7841	0.8043	0.8237

	17	18	19	20
Eigenvalue	0.7507	0.6814	0.6439	0.6006
Difference	0.0692	0.0375	0.0433	0.0363
Proportion	0.0167	0.0151	0.0143	0.0133
Cumulative	0.8404	0.8555	0.8698	0.8832

	21	22	23	24
Eigenvalue	0.5644	0.5046	0.4470	0.4263
Difference	0.0597	0.0576	0.0207	0.0161
Proportion	0.0125	0.0112	0.0099	0.0095
Cumulative	0.8957	0.9069	0.9169	0.9263

Initial Factor Method: Principal Components

	25	26	27	28
Eigenvalue	0.4102	0.3608	0.3402	0.2921
Difference	0.0495	0.0206	0.0481	0.0469
Proportion	0.0091	0.0080	0.0076	0.0065
Cumulative	0.9354	0.9435	0.9510	0.9575

	29	30	31	32
Eigenvalue	0.2452	0.2414	0.2314	0.1960
Difference	0.0038	0.0100	0.0355	0.0293
Proportion	0.0054	0.0054	0.0051	0.0044
Cumulative	0.9630	0.9683	0.9735	0.9778

	33	34	35	36
Eigenvalue	0.1666	0.1501	0.1185	0.1127
Difference	0.0165	0.0316	0.0058	0.0121
Proportion	0.0037	0.0033	0.0026	0.0025
Cumulative	0.9815	0.9849	0.9875	0.9900

	37	38	39	40
Eigenvalue	0.1007	0.0907	0.0681	0.0563
Difference	0.0100	0.0226	0.0118	0.0175
Proportion	0.0022	0.0020	0.0015	0.0013
Cumulative	0.9922	0.9943	0.9958	0.9970

	41	42	43	44
Eigenvalue	0.0388	0.0348	0.0305	0.0201
Difference	0.0040	0.0043	0.0103	0.0105
Proportion	0.0009	0.0008	0.0007	0.0004
Cumulative	0.9979	0.9987	0.9993	0.9998

	45
Eigenvalue	0.0097
Difference	
Proportion	0.0002
Cumulative	1.0000

11 factors will be retained by the NFACTOR criterion.

Initial Factor Method: Principal Components

Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
ES_4_11	0.72343	-0.22918	-0.03813	-0.11420
ES_2_10	0.71897	-0.05056	-0.29218	-0.18061
ES_2_1	0.70053	0.11069	-0.08500	-0.13546
ES_4_2	0.69397	0.04127	0.01365	-0.20145
ES_4_4	0.66436	-0.23958	0.25659	0.04781
ES_2_3	0.65561	-0.01575	-0.25186	-0.26830
ES_2_8	0.64896	-0.05475	-0.27439	-0.09932
ES_1_7	0.63486	0.17444	0.05995	-0.11564
ES_2_7	0.62823	-0.44973	-0.00973	0.06443
ES_4_6	0.62667	-0.35198	0.03133	0.11749
ES_2_2	0.61950	0.09873	-0.28965	0.19459
ES_1_6	0.60869	0.02796	-0.05820	0.06738
ES_2_4	0.60282	-0.28104	-0.20189	0.10351
ES_3_6	0.60117	0.40324	0.07734	0.22141
ES_3_13	0.59808	0.35072	0.24766	0.23881
ES_3_7	0.59584	-0.01165	0.43692	0.26583
ES_1_5	0.59313	0.17678	0.11005	-0.12312
ES_2_9	0.59309	-0.13816	-0.08056	0.05595
ES_1_2	0.57819	0.04320	-0.25852	-0.06701
ES_4_8	0.57317	-0.56121	0.16139	0.21284
ES_3_12	0.55238	0.04135	-0.00353	0.46708
ES_1_8	0.54684	-0.11352	-0.43320	0.02995
ES_4_7	0.53843	-0.43194	-0.01471	0.16715
ES_3_11	0.53797	0.33752	-0.18352	-0.23012
ES_4_5	0.53706	-0.46115	0.14155	0.11804
ES_2_6	0.51681	-0.09013	-0.32143	-0.15354
ES_1_4	0.51395	-0.31846	-0.15890	-0.27834
ES_1_9	0.49824	-0.11570	0.33266	-0.04093
ES_3_5	0.47505	0.38648	0.23738	-0.02003
ES_3_14	0.45485	0.35938	0.40545	0.08407
ES_3_8	0.43337	0.62740	0.01501	-0.22099
ES_3_1	0.54876	0.58181	-0.00103	0.20392
ES_3_9	0.45605	0.56951	-0.17349	-0.01991
ES_3_10	0.37263	0.56461	0.11705	-0.04159
ES_3_4	0.16425	0.37619	0.28774	-0.07060
ES_4_10	0.36679	-0.53604	0.15066	0.10458

Initial Factor Method: Principal Components

Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
ES_4_3	0.41410	-0.20243	0.51579	-0.21668
ES_4_9	0.38549	-0.18098	0.50808	-0.08662
ES_4_1	0.31819	-0.04491	0.43721	-0.13063
ES_1_1	0.33608	0.05052	-0.42453	-0.04728
ES_3_2	0.07745	0.13753	-0.19922	0.76452
ES_3_3	-0.04343	0.13548	-0.28316	0.67153
ES_1_3	0.39793	-0.08697	-0.36948	-0.16607
ES_2_11	0.41819	0.19056	0.02484	-0.15765
ES_2_5	0.42257	0.10989	0.10700	0.20753

Initial Factor Method: Principal Components

Factor Pattern

	FACTOR5	FACTOR6	FACTOR7	FACTOR8
ES_4_11	-0.00495	-0.18988	-0.01681	0.05285
ES_2_10	0.21257	0.04106	-0.06796	-0.18989
ES_2_1	-0.09337	-0.21181	0.13813	-0.34065
ES_4_2	0.14075	-0.04820	0.01465	-0.27956
ES_4_4	-0.24769	0.27788	-0.12311	0.05334
ES_2_3	-0.37145	-0.10571	0.05596	-0.06563
ES_2_8	0.21530	0.12524	-0.09522	0.03815
ES_1_7	0.05678	-0.16664	-0.12528	0.08198
ES_2_7	0.11778	0.36921	-0.19590	-0.18001
ES_4_6	-0.33633	-0.05557	0.29461	-0.01734
ES_2_2	-0.29742	-0.28271	0.04949	-0.22553
ES_1_6	0.31409	0.36679	0.35895	0.02101
ES_2_4	0.09986	0.06589	-0.27026	-0.10349
ES_3_6	-0.05142	-0.34753	0.09305	0.10221
ES_3_13	0.11693	-0.16608	0.15950	-0.12831
ES_3_7	0.01242	-0.23205	0.01834	-0.09641
ES_1_5	0.13276	0.02923	0.03644	0.14271
ES_2_9	0.15940	0.11535	-0.28725	0.06124
ES_1_2	-0.16721	0.01984	-0.07392	0.50047
ES_4_8	-0.04033	0.20338	0.00954	-0.02687
ES_3_12	0.24406	0.17887	-0.11680	0.08687
ES_1_8	0.11199	-0.04414	-0.21674	0.13260
ES_4_7	-0.28990	0.10159	0.23295	-0.06963
ES_3_11	-0.19959	-0.01115	0.10478	0.19873
ES_4_5	0.00980	-0.34443	-0.10875	0.25097
ES_2_6	0.16768	-0.00908	0.12008	-0.37248
ES_1_4	0.22535	0.04573	-0.00468	0.03670
ES_1_9	-0.20490	-0.04514	-0.25412	0.12957
ES_3_5	0.16162	-0.40265	-0.22161	-0.14363
ES_3_14	-0.07912	0.25706	0.00379	0.16407
ES_3_8	-0.22341	0.29015	-0.04451	0.06044
ES_3_1	-0.06711	0.12166	-0.11379	-0.11344
ES_3_9	0.03712	0.01193	-0.33529	-0.03954
ES_3_10	0.01278	0.31861	-0.02362	0.21942
ES_3_4	0.00177	-0.05903	0.35881	-0.14549
ES_4_10	0.12981	-0.11102	0.30095	0.14878

Initial Factor Method: Principal Components

Factor Pattern

	FACTOR5	FACTOR6	FACTOR7	FACTOR8
ES_4_3	0.00130	-0.01700	-0.21452	-0.10396
ES_4_9	0.20066	-0.25736	-0.04876	0.28179
ES_4_1	-0.12118	0.26205	0.31383	-0.09157
ES_1_1	0.20583	-0.22587	0.21328	0.21499
ES_3_2	-0.08061	-0.06212	0.03387	0.15070
ES_3_3	0.11385	0.06139	0.13277	-0.06645
ES_1_3	-0.50249	0.03701	0.19735	0.19473
ES_2_11	0.48700	0.07524	0.50640	0.17672
ES_2_5	-0.22590	0.18955	-0.07167	-0.24188

Initial Factor Method: Principal Components

Factor Pattern

	FACTOR9	FACTOR10	FACTOR11
ES_4_11	-0.08883	-0.08219	-0.33679
ES_2_10	-0.09327	0.22092	-0.07834
ES_2_1	0.23026	0.01733	0.09477
ES_4_2	0.11522	-0.13003	0.08993
ES_4_4	-0.01302	0.02038	-0.23667
ES_2_3	0.14886	0.05284	-0.01891
ES_2_8	0.09127	0.17046	0.12811
ES_1_7	-0.29237	-0.29425	-0.22976
ES_2_7	-0.18311	0.02576	0.12487
ES_4_6	0.04789	0.22029	-0.03540
ES_2_2	-0.00046	-0.08967	0.14148
ES_1_6	-0.03837	0.03149	0.02113
ES_2_4	0.00466	-0.09518	0.25353
ES_3_6	-0.23031	0.01152	-0.04717
ES_3_13	-0.05622	-0.07426	-0.07426
ES_3_7	0.12388	0.13984	0.12792
ES_1_5	-0.40392	-0.12977	0.13820
ES_2_9	-0.11849	0.15163	0.20243
ES_1_2	-0.18586	0.01900	0.12053
ES_4_8	-0.02629	-0.04125	-0.31400
ES_3_12	0.20233	-0.00166	-0.15430
ES_1_8	0.06935	0.12186	0.05635
ES_4_7	-0.19696	0.10101	-0.12053
ES_3_11	0.30610	0.01789	-0.24475
ES_4_5	0.22987	-0.18093	-0.08400
ES_2_6	-0.23400	-0.07981	-0.02724
ES_1_4	0.40069	-0.01484	-0.07769
ES_1_9	-0.14117	-0.01464	0.20859
ES_3_5	-0.19289	0.28134	-0.13720
ES_3_14	0.10490	0.08687	-0.14948
ES_3_8	-0.07870	0.08054	-0.01601
ES_3_1	0.01314	-0.13439	0.10271
ES_3_9	0.26336	0.10622	0.08520
ES_3_10	0.07032	0.00804	0.02028
ES_3_4	0.05390	0.30415	0.12639
ES_4_10	0.11555	0.14946	0.23338

Initial Factor Method: Principal Components

Factor Pattern

	FACTOR9	FACTOR10	FACTOR11
ES_4_3	-0.02556	0.08150	-0.08887
ES_4_9	0.09744	0.02153	0.20715
ES_4_1	-0.09893	-0.29596	0.33281
ES_1_1	-0.11481	-0.42181	0.00615
ES_3_2	0.14049	-0.07866	0.21635
ES_3_3	-0.18504	0.22113	-0.17707
ES_1_3	-0.09377	0.15396	0.13229
ES_2_11	0.10811	-0.02755	-0.08061
ES_2_5	0.25346	-0.48978	-0.04386

Variance explained by each factor

FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6
12.788804	4.133515	2.816315	2.255213	1.815427	1.681794

FACTOR7	FACTOR8	FACTOR9	FACTOR10	FACTOR11
1.645307	1.400616	1.303587	1.220405	1.115627

Initial Factor Method: Principal Components

Final Communality Estimates: Total = 32.176609

ES_1_1	ES_1_2	ES_1_3	ES_1_4	ES_1_5	ES_1_6
0.674203	0.741213	0.710736	0.689341	0.649588	0.744598
ES_1_7	ES_1_8	ES_1_9	ES_2_1	ES_2_2	ES_2_3
0.728711	0.602369	0.563010	0.779571	0.765045	0.747394
ES_2_4	ES_2_5	ES_2_6	ES_2_7	ES_2_8	ES_2_9
0.665267	0.701817	0.645332	0.871933	0.635665	0.583445
ES_2_10	ES_2_11	ES_3_1	ES_3_2	ES_3_3	ES_3_4
0.788660	0.786117	0.755127	0.756031	0.704639	0.521057
ES_3_5	ES_3_6	ES_3_7	ES_3_8	ES_3_9	ES_3_10
0.824952	0.776940	0.731629	0.783172	0.766229	0.628874
ES_3_11	ES_3_12	ES_3_13	ES_3_14	ES_4_1	ES_4_2
0.734321	0.702503	0.696422	0.647663	0.709849	0.662840
ES_4_3	ES_4_4	ES_4_5	ES_4_6	ES_4_7	ES_4_8
0.597757	0.780060	0.821230	0.786764	0.721630	0.859618
ES_4_9	ES_4_10	ES_4_11			
0.688151	0.687540	0.757594			

Rotation Method: Varimax

Orthogonal Transformation Matrix

	1	2	3	4
1	0.53756	0.33131	0.39289	0.36112
2	-0.22257	0.68773	-0.48539	0.36836
3	-0.40356	0.17532	0.28355	0.27189
4	-0.05326	-0.06293	0.23443	0.10375
5	0.37232	-0.14362	-0.21566	0.10731
6	0.19859	0.44729	0.30964	-0.56038
7	-0.40235	-0.18821	0.04732	0.02711
8	-0.16291	0.32729	-0.02414	-0.39467
9	-0.04492	0.11374	-0.16793	-0.29833
10	0.16831	0.05213	0.03749	0.25592
11	0.31457	-0.06057	-0.54760	-0.11258

	5	6	7	8
1	0.33519	0.24804	0.00629	0.20175
2	-0.05290	-0.28012	0.11739	0.04958
3	-0.39547	0.50331	-0.24961	-0.04455
4	-0.21049	0.03211	0.92143	-0.12510
5	-0.66164	0.08091	-0.00011	0.53655
6	-0.20680	-0.35818	-0.00738	0.13224
7	0.34458	-0.10571	0.13982	0.73839
8	0.09747	0.47889	0.16533	0.04883
9	0.08611	0.35032	0.02157	0.25988
10	0.21334	-0.01042	0.03426	0.05080
11	0.14981	0.32783	0.16208	-0.12691

Rotation Method: Varimax

Orthogonal Transformation Matrix

	9	10	11
1	0.22134	0.21867	0.07116
2	0.05405	0.07192	-0.02455
3	-0.26671	0.01525	0.32665
4	-0.08550	0.09984	-0.01364
5	0.12555	-0.15194	-0.10805
6	-0.26310	-0.02771	0.30332
7	-0.01077	-0.04270	0.32109
8	0.40567	-0.50135	-0.15972
9	-0.41159	0.53130	-0.46692
10	-0.64121	-0.61441	-0.25301
11	-0.19852	0.00136	0.61085

Rotation Method: Varimax

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
ES_2_7	0.71546	-0.00778	0.52480	-0.01612
ES_2_4	0.70195	-0.02313	0.18566	0.02302
ES_2_10	0.68758	0.10771	0.21691	0.30892
ES_2_8	0.67909	0.20251	0.08828	0.06653
ES_2_9	0.66148	0.16881	0.19136	0.11905
ES_1_8	0.62611	0.08446	0.06493	0.02368
ES_2_6	0.49727	-0.13923	0.14658	0.27590
ES_1_4	0.47006	-0.00859	0.18535	-0.13444
ES_4_2	0.45280	0.13822	0.09796	0.32368
ES_3_8	0.09360	0.77784	-0.02236	0.20302
ES_3_10	0.07599	0.75902	-0.03734	0.08444
ES_3_14	-0.04736	0.66849	0.29931	0.20617
ES_3_1	0.22759	0.60554	-0.03328	0.34979
ES_3_9	0.37986	0.59410	-0.25724	0.26807
ES_3_11	0.06160	0.51224	0.06460	0.09487
ES_4_8	0.27793	-0.08111	0.84084	-0.00858
ES_4_4	0.23773	0.31173	0.72617	0.05544
ES_4_7	0.20040	-0.12116	0.66576	0.09261
ES_4_11	0.30418	0.02482	0.49435	0.28255
ES_3_5	0.18025	0.25848	0.01319	0.81502
ES_3_6	0.04561	0.32126	0.08465	0.63801
ES_3_13	0.06473	0.29889	0.17228	0.60399
ES_3_7	0.15749	0.12232	0.26903	0.51160
ES_3_4	-0.15099	0.24055	-0.11805	0.41674
ES_1_3	0.17210	0.12236	0.12840	-0.09971
ES_2_3	0.29700	0.17399	0.16986	0.15268
ES_4_6	0.16813	-0.05495	0.54278	0.17331
ES_2_2	0.29696	0.02996	0.06259	0.37964
ES_2_1	0.33893	0.10437	0.04505	0.42852
ES_1_2	0.34845	0.36332	0.10973	-0.03438
ES_4_9	0.10880	0.05491	0.10200	0.20803
ES_4_5	0.19885	-0.15288	0.38330	0.06144
ES_4_10	0.22445	-0.29675	0.27821	-0.01010
ES_1_9	0.22690	0.21642	0.26064	0.18367
ES_3_2	0.01868	0.06272	-0.06248	-0.01502
ES_3_3	0.02682	-0.04754	0.13298	0.16628

Rotation Method: Varimax

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
ES_3_12	0.36561	0.30908	0.35103	0.10729
ES_4_3	0.15831	0.10732	0.39924	0.27609
ES_2_11	0.10963	0.22587	0.00482	0.13546
ES_1_6	0.39649	0.26072	0.28324	0.06800
ES_1_1	0.19030	-0.06115	-0.13326	0.01485
ES_1_7	0.20085	0.28113	0.24678	0.39933
ES_1_5	0.29874	0.31791	0.11556	0.31072
ES_2_5	0.06262	0.27879	0.26463	0.01074
ES_4_1	-0.03355	0.15815	0.18777	0.00478

Rotation Method: Varimax

Rotated Factor Pattern

	FACTOR5	FACTOR6	FACTOR7	FACTOR8
ES_2_7	-0.00624	0.06728	-0.02976	-0.00673
ES_2_4	0.11015	0.17918	0.09911	-0.07439
ES_2_10	0.23354	-0.10228	-0.14326	0.23511
ES_2_8	0.21582	0.10810	-0.00475	0.23262
ES_2_9	0.05633	0.20161	0.06372	-0.04772
ES_1_8	0.26800	0.10314	0.13258	0.03801
ES_2_6	0.19219	-0.27760	-0.12551	0.23116
ES_1_4	0.17365	0.26275	-0.25036	0.36834
ES_4_2	0.15774	0.12540	-0.21104	0.24488
ES_3_8	0.23903	-0.18980	-0.13088	0.01977
ES_3_10	0.00721	0.01753	0.03678	0.16153
ES_3_14	-0.02293	0.18545	0.02809	0.13400
ES_3_1	0.06748	-0.07246	0.23667	-0.01183
ES_3_9	0.10723	-0.00005	0.06430	-0.03452
ES_3_11	0.46683	0.03789	-0.10807	0.25226
ES_4_8	0.04037	0.18573	0.03608	0.09591
ES_4_4	0.16079	0.19920	-0.09229	-0.05202
ES_4_7	0.40477	0.02513	0.11039	0.06270
ES_4_11	0.25999	0.17480	-0.16959	0.12846
ES_3_5	-0.04204	0.12486	-0.09789	-0.04867
ES_3_6	0.22646	0.14536	0.25609	0.05700
ES_3_13	0.00134	0.12980	0.18967	0.24047
ES_3_7	0.06795	0.49938	0.15480	0.07478
ES_3_4	0.14518	0.04875	-0.03306	0.31220
ES_1_3	0.77545	-0.04084	0.01577	-0.02961
ES_2_3	0.67844	0.04751	-0.18232	0.04488
ES_4_6	0.57122	0.22969	0.10468	0.14990
ES_2_2	0.52836	-0.00242	0.25869	-0.07563
ES_2_1	0.44878	0.09775	-0.10071	0.22350
ES_1_2	0.44381	0.20010	0.09995	-0.04117
ES_4_9	-0.06878	0.74959	-0.14739	0.10852
ES_4_5	0.14393	0.64814	0.03665	0.01729
ES_4_10	0.20177	0.52545	0.11107	0.32008
ES_1_9	0.13613	0.42969	-0.11469	-0.27604
ES_3_2	0.05681	0.11025	0.83632	-0.07836
ES_3_3	-0.09513	-0.35349	0.68707	0.07618

Rotation Method: Varimax

Rotated Factor Pattern

	FACTOR5	FACTOR6	FACTOR7	FACTOR8
ES_3_12	-0.15025	0.16859	0.41557	0.19990
ES_4_3	-0.08838	0.35220	-0.40878	-0.07861
ES_2_11	-0.00125	0.11307	-0.03872	0.80316
ES_1_6	0.06003	-0.02467	0.13833	0.59040
ES_1_1	0.19384	-0.00182	0.12152	0.29165
ES_1_7	0.04356	0.07718	-0.15341	0.00669
ES_1_5	0.06267	0.11895	-0.07873	0.11880
ES_2_5	0.02259	0.01964	0.11027	-0.05434
ES_4_1	0.06702	0.20420	-0.16428	0.17274

Rotation Method: Varimax

Rotated Factor Pattern

	FACTOR9	FACTOR10	FACTOR11
ES_2_7	-0.00738	0.06886	0.27206
ES_2_4	0.12815	0.22658	0.09816
ES_2_10	0.10165	0.01036	-0.10278
ES_2_8	0.06064	0.01656	-0.07018
ES_2_9	0.06946	-0.07758	0.07489
ES_1_8	0.19181	-0.00317	-0.24526
ES_2_6	0.23231	0.16736	0.12608
ES_1_4	0.05395	0.22746	-0.25235
ES_4_2	0.10431	0.39552	0.10914
ES_3_8	0.04926	0.02424	0.11814
ES_3_10	0.05426	0.03241	0.08160
ES_3_14	-0.07548	0.06452	0.05410
ES_3_1	0.11090	0.34043	0.13799
ES_3_9	-0.02463	0.23900	-0.23747
ES_3_11	0.17444	0.19397	-0.30368
ES_4_8	0.06531	0.13319	0.00869
ES_4_4	0.01961	0.12542	0.05568
ES_4_7	0.03180	0.00246	0.18267
ES_4_11	0.39474	0.11280	-0.16814
ES_3_5	0.06101	-0.07416	-0.15060
ES_3_6	0.33751	0.01646	0.04462
ES_3_13	0.15497	0.24363	0.11996
ES_3_7	-0.15075	0.19483	0.11626
ES_3_4	-0.30346	-0.03877	0.19284
ES_1_3	0.11379	-0.11643	0.09545
ES_2_3	0.09693	0.24808	-0.08948
ES_4_6	-0.09047	0.06272	0.07900
ES_2_2	0.17769	0.37660	0.05202
ES_2_1	-0.02508	0.44308	0.01181
ES_1_2	0.42299	-0.21425	0.03257
ES_4_9	0.06015	-0.05335	0.11420
ES_4_5	0.27901	0.21827	-0.19923
ES_4_10	-0.08402	-0.07982	0.16301
ES_1_9	0.08633	0.01416	0.25071
ES_3_2	0.02901	0.16036	-0.01023
ES_3_3	-0.04490	-0.16280	-0.12621

Rotation Method: Varimax

Rotated Factor Pattern

	FACTOR9	FACTOR10	FACTOR11
ES_3_12	0.05401	0.19805	-0.18103
ES_4_3	-0.09765	0.06001	0.08533
ES_2_11	0.20648	-0.02226	0.04717
ES_1_6	0.08499	0.01750	0.23477
ES_1_1	0.68108	0.12220	-0.00787
ES_1_7	0.58405	0.12612	0.02267
ES_1_5	0.41052	-0.09697	0.36478
ES_2_5	0.09605	0.71159	0.13580
ES_4_1	0.00229	0.23336	0.70068

Variance explained by each factor

FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6
5.134552	4.060837	3.921555	3.439566	3.154405	2.674164

FACTOR7	FACTOR8	FACTOR9	FACTOR10	FACTOR11
2.249562	2.133201	1.997760	1.882949	1.528057

Rotation Method: Varimax

Final Communality Estimates: Total = 32.176609

ES_1_1	ES_1_2	ES_1_3	ES_1_4	ES_1_5	ES_1_6
0.674203	0.741213	0.710736	0.689341	0.649588	0.744598
ES_1_7	ES_1_8	ES_1_9	ES_2_1	ES_2_2	ES_2_3
0.728711	0.602369	0.563010	0.779571	0.765045	0.747394
ES_2_4	ES_2_5	ES_2_6	ES_2_7	ES_2_8	ES_2_9
0.665267	0.701817	0.645332	0.871933	0.635665	0.583445
ES_2_10	ES_2_11	ES_3_1	ES_3_2	ES_3_3	ES_3_4
0.788660	0.786117	0.755127	0.756031	0.704639	0.521057
ES_3_5	ES_3_6	ES_3_7	ES_3_8	ES_3_9	ES_3_10
0.824952	0.776940	0.731629	0.783172	0.766229	0.628874
ES_3_11	ES_3_12	ES_3_13	ES_3_14	ES_4_1	ES_4_2
0.734321	0.702503	0.696422	0.647663	0.709849	0.662840
ES_4_3	ES_4_4	ES_4_5	ES_4_6	ES_4_7	ES_4_8
0.597757	0.780060	0.821230	0.786764	0.721630	0.859618
ES_4_9	ES_4_10	ES_4_11			
0.688151	0.687540	0.757594			

Scoring Coefficients Estimated by Regression

Squared Multiple Correlations of the Variables with each Factor

FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6
1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
FACTOR7	FACTOR8	FACTOR9	FACTOR10	FACTOR11	
1.000000	1.000000	1.000000	1.000000	1.000000	

Rotation Method: Varimax

Standardized Scoring Coefficients

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
ES_2_7	0.23216	-0.01339	0.09237	-0.05417
ES_2_4	0.23155	-0.04767	-0.09174	-0.06071
ES_2_10	0.17782	-0.03988	0.02071	0.10613
ES_2_8	0.20617	0.03776	-0.08691	-0.05701
ES_2_9	0.23410	0.03618	-0.05431	-0.01328
ES_1_8	0.17611	0.01085	-0.07317	-0.05073
ES_2_6	0.11291	-0.15613	0.00748	0.12790
ES_1_4	0.07883	0.00020	-0.02480	-0.14132
ES_4_2	0.08531	-0.06002	-0.08643	0.05601
ES_3_8	-0.01089	0.23422	0.01629	-0.03170
ES_3_10	-0.00563	0.25512	-0.01348	-0.11385
ES_3_14	-0.09998	0.22798	0.13786	-0.03933
ES_3_1	0.03867	0.11927	-0.05755	0.02066
ES_3_9	0.13905	0.14857	-0.15606	0.00320
ES_3_11	-0.13191	0.15313	0.03699	-0.08700
ES_4_8	-0.05063	-0.01151	0.32110	-0.04182
ES_4_4	-0.05463	0.12462	0.27394	-0.06877
ES_4_7	-0.06555	-0.06279	0.23184	0.03387
ES_4_11	-0.07780	-0.04739	0.17189	0.07596
ES_3_5	0.02888	-0.03351	-0.00537	0.36737
ES_3_6	-0.10276	-0.01086	-0.00187	0.21594
ES_3_13	-0.08383	-0.02309	0.03069	0.18886
ES_3_7	-0.01025	-0.04421	-0.02516	0.16378
ES_3_4	-0.05462	0.00668	-0.07539	0.16806
ES_1_3	-0.02955	0.04121	-0.01133	-0.09308
ES_2_3	-0.02706	0.00198	-0.01212	-0.00794
ES_4_6	-0.08879	-0.05407	0.13242	0.04194
ES_2_2	0.00493	-0.11256	-0.08504	0.11529
ES_2_1	0.02172	-0.09361	-0.10782	0.11990
ES_1_2	0.03153	0.12990	-0.04218	-0.13225
ES_4_9	0.00312	-0.00080	-0.11580	0.01854
ES_4_5	-0.07348	-0.06170	0.03120	-0.04607
ES_4_10	0.02527	-0.10888	-0.05436	-0.02901
ES_1_9	0.04185	0.05479	-0.02003	0.00441
ES_3_2	0.00198	0.00950	-0.08455	-0.06607
ES_3_3	0.00840	-0.03543	0.14434	0.12818

Rotation Method: Varimax

Standardized Scoring Coefficients

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
ES_3_12	0.04939	0.09582	0.10901	-0.06223
ES_4_3	0.00939	0.01690	0.10766	0.09689
ES_2_11	-0.05841	0.02597	-0.03110	-0.03618
ES_1_6	0.05996	0.04832	0.05228	-0.07324
ES_1_1	-0.04075	-0.08688	-0.10806	-0.06160
ES_1_7	-0.07079	0.01150	0.09199	0.09605
ES_1_5	0.04271	0.03323	-0.03584	0.04724
ES_2_5	-0.07533	0.05364	0.07010	-0.12422
ES_4_1	-0.04734	0.01428	-0.04097	-0.09533

Rotation Method: Varimax

Standardized Scoring Coefficients

	FACTOR5	FACTOR6	FACTOR7	FACTOR8
ES_2_7	-0.11513	-0.09324	-0.00896	-0.07890
ES_2_4	-0.05250	0.04509	0.05126	-0.11849
ES_2_10	-0.01065	-0.14722	-0.08409	0.05382
ES_2_8	0.00739	0.02865	0.00326	0.06222
ES_2_9	-0.05891	0.05554	0.04038	-0.10507
ES_1_8	0.03572	0.04912	0.05785	-0.03807
ES_2_6	-0.01967	-0.23937	-0.08035	0.06355
ES_1_4	-0.00690	0.09732	-0.10978	0.17972
ES_4_2	-0.03025	-0.01125	-0.10223	0.06436
ES_3_8	0.06921	-0.10934	-0.07287	-0.04521
ES_3_10	-0.03476	0.02333	0.01568	0.05103
ES_3_14	-0.04598	0.03923	0.00987	0.04619
ES_3_1	-0.04301	-0.05158	0.08798	-0.07561
ES_3_9	-0.00968	0.04100	0.01014	-0.07484
ES_3_11	0.15740	0.01637	-0.06548	0.11190
ES_4_8	-0.08162	-0.07287	0.00654	0.02413
ES_4_4	-0.01506	-0.04163	-0.04908	-0.07867
ES_4_7	0.13167	-0.12308	0.05081	-0.00265
ES_4_11	-0.00224	-0.04165	-0.09650	0.01069
ES_3_5	-0.07174	-0.01131	-0.06727	-0.09001
ES_3_6	0.04761	0.02615	0.10652	-0.03646
ES_3_13	-0.07026	-0.01434	0.07120	0.07923
ES_3_7	0.00054	0.17973	0.08561	-0.00614
ES_3_4	0.11101	0.01699	-0.00221	0.16733
ES_1_3	0.35088	-0.01880	0.02424	-0.05728
ES_2_3	0.24985	-0.02113	-0.08873	-0.03222
ES_4_6	0.23239	0.01585	0.06063	0.04924
ES_2_2	0.17860	-0.03479	0.10516	-0.11096
ES_2_1	0.13779	-0.00585	-0.05380	0.06295
ES_1_2	0.14223	0.11063	0.06473	-0.09611
ES_4_9	-0.04491	0.35942	-0.02282	0.02445
ES_4_5	-0.00517	0.27387	0.03126	-0.02224
ES_4_10	0.09037	0.23117	0.09797	0.16377
ES_1_9	0.02380	0.16097	-0.02778	-0.22263
ES_3_2	0.03607	0.12845	0.38646	-0.04451
ES_3_3	-0.04899	-0.19397	0.28388	0.05637

Rotation Method: Varimax

Standardized Scoring Coefficients

	FACTOR5	FACTOR6	FACTOR7	FACTOR8
ES_3_12	-0.16615	0.03297	0.17301	0.07798
ES_4_3	-0.08868	0.05907	-0.18126	-0.08448
ES_2_11	-0.05714	0.03656	-0.00816	0.43009
ES_1_6	-0.05965	-0.08390	0.06846	0.28187
ES_1_1	0.00408	0.01819	0.05154	0.12039
ES_1_7	-0.10555	-0.05991	-0.09402	-0.07651
ES_1_5	-0.05591	-0.00325	-0.02519	-0.02222
ES_2_5	-0.07231	-0.04630	0.02725	-0.06255
ES_4_1	0.01743	0.04655	-0.04012	0.05735

Rotation Method: Varimax

Standardized Scoring Coefficients

	FACTOR9	FACTOR10	FACTOR11
ES_2_7	-0.07494	-0.02815	0.17514
ES_2_4	-0.00623	0.09365	0.10286
ES_2_10	-0.07266	-0.09623	-0.08064
ES_2_8	-0.09394	-0.07547	-0.03833
ES_2_9	-0.05172	-0.14431	0.06456
ES_1_8	0.00639	-0.07715	-0.13800
ES_2_6	0.06903	0.05984	0.10680
ES_1_4	-0.05546	0.12812	-0.20524
ES_4_2	-0.02896	0.20497	0.05901
ES_3_8	-0.03501	-0.07058	0.05454
ES_3_10	-0.01096	-0.04462	0.02387
ES_3_14	-0.07937	-0.03765	-0.05741
ES_3_1	0.00187	0.14884	0.09430
ES_3_9	-0.13015	0.08940	-0.15153
ES_3_11	0.02215	0.06238	-0.25861
ES_4_8	0.02262	0.02940	-0.08599
ES_4_4	-0.02658	-0.00490	-0.05980
ES_4_7	-0.02835	-0.08079	0.07543
ES_4_11	0.19340	-0.00706	-0.17715
ES_3_5	-0.03693	-0.15491	-0.14546
ES_3_6	0.15482	-0.10118	0.00974
ES_3_13	0.04827	0.07736	0.03224
ES_3_7	-0.16753	0.04118	0.02111
ES_3_4	-0.25126	-0.07963	0.09518
ES_1_3	-0.01322	-0.15301	0.08787
ES_2_3	-0.05476	0.08661	-0.07703
ES_4_6	-0.14726	-0.05385	-0.00424
ES_2_2	0.01216	0.17348	0.06640
ES_2_1	-0.14480	0.22234	-0.00682
ES_1_2	0.19562	-0.24245	0.04404
ES_4_9	0.01661	-0.08067	0.03672
ES_4_5	0.15078	0.10967	-0.18193
ES_4_10	-0.10797	-0.09557	0.09149
ES_1_9	0.02439	-0.06531	0.14978
ES_3_2	-0.00093	0.08656	0.03935
ES_3_3	-0.04572	-0.14735	-0.07668

Rotation Method: Varimax

Standardized Scoring Coefficients

	FACTOR9	FACTOR10	FACTOR11
ES_3_12	-0.02800	0.06250	-0.17198
ES_4_3	-0.08101	-0.01184	-0.02491
ES_2_11	0.07782	-0.05694	-0.00886
ES_1_6	-0.02626	-0.06707	0.12996
ES_1_1	0.41570	0.07181	0.04868
ES_1_7	0.35434	0.00969	-0.01716
ES_1_5	0.22365	-0.15438	0.25122
ES_2_5	0.06100	0.47296	0.06082
ES_4_1	0.01803	0.14078	0.45872

Maximum R-square Improvement for Dependent Variable COST_OVR

Step 1 Variable FACTOR2 Entered R-square = 0.17563328 C(p) = 15.98325167

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	0.18611900	0.18611900	13.85	0.0004
Error	65	0.87358337	0.01343974		
Total	66	1.05970237			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.11315052	0.01416309	0.85780373	63.83	0.0001
FACTOR2	0.05310353	0.01426999	0.18611900	13.85	0.0004

Bounds on condition number: 1, 1

The above model is the best 1-variable model found.

Step 2 Variable FACTOR5 Entered R-square = 0.23291846 C(p) = 12.49471166

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	0.24682424	0.12341212	9.72	0.0002
Error	64	0.81287813	0.01270122		
Total	66	1.05970237			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F

```
INTERCEP       0.11315052     0.01376846     0.85780373
  67.54   0.0001
FACTOR2        0.05310353     0.01387237     0.18611900
  14.65   0.0003
FACTOR5        0.03032782     0.01387237     0.06070524
   4.78   0.0325

Bounds on condition number:          1,            4
-----------------------------------------------------------------

The above model is the best  2-variable model found.

Step 3   Variable FACTOR10 Entered  R-square = 0.28021235   C(p) =
  9.96344575

                 DF          Sum of Squares      Mean Square
F    Prob>F

Regression        3            0.29694169       0.09898056
   8.18   0.0001
Error            63            0.76276069       0.01210731
Total            66            1.05970237

                 Parameter        Standard          Type II
Variable          Estimate           Error   Sum of Squares
F    Prob>F

INTERCEP       0.11315052     0.01344270     0.85780373
  70.85   0.0001
FACTOR2        0.05310353     0.01354415     0.18611900
  15.37   0.0002
FACTOR5        0.03032782     0.01354415     0.06070524
   5.01   0.0287
FACTOR10       0.02755640     0.01354415     0.05011744
   4.14   0.0461

Bounds on condition number:          1,            9
-----------------------------------------------------------------

The above model is the best  3-variable model found.
```

Step 4 Variable FACTOR4 Entered R-square = 0.32334030 C(p) = 7.83132060

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	4	0.34264449	0.08566112	7.41	0.0001
Error	62	0.71705789	0.01156545		
Total	66	1.05970237			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.11315052	0.01313844	0.85780373	74.17	0.0001
FACTOR2	0.05310353	0.01323760	0.18611900	16.09	0.0002
FACTOR4	0.02631476	0.01323760	0.04570280	3.95	0.0512
FACTOR5	0.03032782	0.01323760	0.06070524	5.25	0.0254
FACTOR10	0.02755640	0.01323760	0.05011744	4.33	0.0415

Bounds on condition number: 1, 16

The above model is the best 4-variable model found.

Step 5 Variable FACTOR3 Entered R-square = 0.35700511 C(p) = 6.60586806

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	5	0.37831916	0.07566383	6.77	0.0001
Error	61	0.68138321	0.01117022		
Total	66	1.05970237			

```
                 Parameter        Standard          Type II
Variable          Estimate           Error   Sum of Squares
F   Prob>F

INTERCEP        0.11315052      0.01291200       0.85780373
  76.79    0.0001
FACTOR2         0.05310353      0.01300945       0.18611900
  16.66    0.0001
FACTOR3         0.02324920      0.01300945       0.03567467
   3.19    0.0789
FACTOR4         0.02631476      0.01300945       0.04570280
   4.09    0.0475
FACTOR5         0.03032782      0.01300945       0.06070524
   5.43    0.0231
FACTOR10        0.02755640      0.01300945       0.05011744
   4.49    0.0382

Bounds on condition number:            1,           25
------------------------------------------------------------------

The above model is the best  5-variable model found.

Step 6   Variable FACTOR7 Entered   R-square = 0.38425148   C(p) =
  5.99537061

                 DF        Sum of Squares       Mean Square
F   Prob>F

Regression        6            0.40719221        0.06786537
   6.24    0.0001
Error            60            0.65251016        0.01087517
Total            66            1.05970237

                 Parameter        Standard          Type II
Variable          Estimate           Error   Sum of Squares
F   Prob>F

INTERCEP        0.11315052      0.01274033       0.85780373
  78.88    0.0001
FACTOR2         0.05310353      0.01283648       0.18611900
  17.11    0.0001
FACTOR3         0.02324920      0.01283648       0.03567467
```

```
   3.28   0.0751
FACTOR4          0.02631476       0.01283648        0.04570280
   4.20   0.0447
FACTOR5          0.03032782       0.01283648        0.06070524
   5.58   0.0214
FACTOR7         -0.02091579       0.01283648        0.02887305
   2.65   0.1085
FACTOR10         0.02755640       0.01283648        0.05011744
   4.61   0.0359

Bounds on condition number:            1,            36
-----------------------------------------------------------------

The above model is the best  6-variable model found.

Step 7   Variable FACTOR9 Entered   R-square = 0.40581230   C(p) =
  5.92961066

                DF        Sum of Squares      Mean Square
F   Prob>F

Regression       7          0.43004026       0.06143432
   5.76   0.0001
Error           59          0.62966211       0.01067224
Total           66          1.05970237

                Parameter        Standard          Type II
Variable         Estimate           Error     Sum of Squares
F   Prob>F

INTERCEP         0.11315052       0.01262090       0.85780373
  80.38   0.0001
FACTOR2          0.05310353       0.01271615       0.18611900
  17.44   0.0001
FACTOR3          0.02324920       0.01271615       0.03567467
   3.34   0.0726
FACTOR4          0.02631476       0.01271615       0.04570280
   4.28   0.0429
FACTOR5          0.03032782       0.01271615       0.06070524
   5.69   0.0203
FACTOR7         -0.02091579       0.01271615       0.02887305
   2.71   0.1053
```

```
FACTOR9         0.01860598      0.01271615      0.02284805
   2.14   0.1487
FACTOR10        0.02755640      0.01271615      0.05011744
   4.70   0.0343

Bounds on condition number:            1,           49
-----------------------------------------------------------------

The above model is the best  7-variable model found.

Step 8   Variable FACTOR11 Entered  R-square = 0.42074058   C(p) =
  6.49932063

                DF          Sum of Squares      Mean Square
F   Prob>F

Regression       8           0.44585979       0.05573247
   5.27   0.0001
Error           58           0.61384259       0.01058349
Total           66           1.05970237

                Parameter        Standard          Type II
Variable         Estimate           Error   Sum of Squares
F   Prob>F

INTERCEP        0.11315052      0.01256832      0.85780373
  81.05   0.0001
FACTOR2         0.05310353      0.01266317      0.18611900
  17.59   0.0001
FACTOR3         0.02324920      0.01266317      0.03567467
   3.37   0.0715
FACTOR4         0.02631476      0.01266317      0.04570280
   4.32   0.0421
FACTOR5         0.03032782      0.01266317      0.06070524
   5.74   0.0199
FACTOR7        -0.02091579      0.01266317      0.02887305
   2.73   0.1040
FACTOR9         0.01860598      0.01266317      0.02284805
   2.16   0.1472
FACTOR10        0.02755640      0.01266317      0.05011744
   4.74   0.0336
FACTOR11        0.01548192      0.01266317      0.01581953
```

1.49 0.2264

Bounds on condition number: 1, 64

The above model is the best 8-variable model found.

Step 9 Variable FACTOR8 Entered R-square = 0.42471502 C(p) = 8.11852603

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	9	0.45007151	0.05000795	4.68	0.0001
Error	57	0.60963086	0.01069528		
Total	66	1.05970237			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.11315052	0.01263452	0.85780373	80.20	0.0001
FACTOR2	0.05310353	0.01272987	0.18611900	17.40	0.0001
FACTOR3	0.02324920	0.01272987	0.03567467	3.34	0.0730
FACTOR4	0.02631476	0.01272987	0.04570280	4.27	0.0433
FACTOR5	0.03032782	0.01272987	0.06070524	5.68	0.0206
FACTOR7	-0.02091579	0.01272987	0.02887305	2.70	0.1059
FACTOR8	0.00798837	0.01272987	0.00421173	0.39	0.5328
FACTOR9	0.01860598	0.01272987	0.02284805	2.14	0.1493
FACTOR10	0.02755640	0.01272987	0.05011744	4.69	0.0346
FACTOR11	0.01548192	0.01272987	0.01581953	1.48	0.2289

Bounds on condition number: 1, 81

The above model is the best 9-variable model found.

Step10 Variable FACTOR1 Entered R-square = 0.42592802 C(p) = 10.00230720

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	10	0.45135694	0.04513569	4.15	0.0003
Error	56	0.60834544	0.01086331		
Total	66	1.05970237			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.11315052	0.01273338	0.85780373	78.96	0.0001
FACTOR1	0.00441317	0.01282948	0.00128542	0.12	0.7321
FACTOR2	0.05310353	0.01282948	0.18611900	17.13	0.0001
FACTOR3	0.02324920	0.01282948	0.03567467	3.28	0.0753
FACTOR4	0.02631476	0.01282948	0.04570280	4.21	0.0449
FACTOR5	0.03032782	0.01282948	0.06070524	5.59	0.0216
FACTOR7	-0.02091579	0.01282948	0.02887305	2.66	0.1087
FACTOR8	0.00798837	0.01282948	0.00421173	0.39	0.5360
FACTOR9	0.01860598	0.01282948	0.02284805	2.10	0.1526
FACTOR10	0.02755640	0.01282948	0.05011744	4.61	0.0361
FACTOR11	0.01548192	0.01282948	0.01581953	1.46	0.2326

Bounds on condition number: 1, 100

The above model is the best 10-variable model found.

Step11 Variable FACTOR6 Entered R-square = 0.42595210 C(p) = 12.00000000

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	11	0.45138245	0.04103477	3.71	0.0006
Error	55	0.60831992	0.01106036		
Total	66	1.05970237			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.11315052	0.01284835	0.85780373	77.56	0.0001
FACTOR1	0.00441317	0.01294532	0.00128542	0.12	0.7345
FACTOR2	0.05310353	0.01294532	0.18611900	16.83	0.0001
FACTOR3	0.02324920	0.01294532	0.03567467	3.23	0.0780
FACTOR4	0.02631476	0.01294532	0.04570280	4.13	0.0469
FACTOR5	0.03032782	0.01294532	0.06070524	5.49	0.0228
FACTOR6	-0.00062181	0.01294532	0.00002552	0.00	0.9619
FACTOR7	-0.02091579	0.01294532	0.02887305	2.61	0.1119
FACTOR8	0.00798837	0.01294532	0.00421173	0.38	0.5397
FACTOR9	0.01860598	0.01294532	0.02284805	2.07	0.1563
FACTOR10	0.02755640	0.01294532	0.05011744	4.53	0.0378

FACTOR11 0.01548192 0.01294532 0.01581953
1.43 0.2368

Bounds on condition number: 1, 121

The above model is the best 11-variable model found.

No further improvement in R-square is possible.

MODEL Procedure

Model Summary

Model Variables	1
Parameters	1
Equations	1
Number of Statements	1

Model Variables: COST_OVR

Parameters: B1

Equations: COST_OVR

MODEL Procedure

The Equation to Estimate is:

COST_OVR = F(B1(1))

MODEL Procedure
OLS Estimation

OLS Estimation Summary

Dataset Option	Dataset
DATA=	FSCORES

Parameters Estimated	1

Minimization Summary

Method	GAUSS
Iterations	1

Final Convergence	Criteria
R	0
PPC	0
RPC(B1)	1119.312
Object	0.44690108
Trace(S)	0.0160561
Objective Value	0.01581645

Observations Processed

Read	67
Solved	67

MODEL Procedure
OLS Estimation

Nonlinear OLS Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	R-Square	Adj R-Sq
COST_OVR	1	66	1.0597	0.01606	-0.0000	-0.0000

Nonlinear OLS Parameter Estimates

Parameter	Estimate	Approx. Std Err	'T' Ratio	Approx. Prob>|T|
B1	0.113151	0.01548	7.31	0.0001

Number of Observations		Statistics for System	
Used	67	Objective	0.0158
Missing	0	Objective*N	1.0597

MODEL Procedure

Model Summary

Model Variables	1
Parameters	6
Equations	1
Number of Statements	1

Model Variables: COST_OVR

Parameters: B1 B2 B3 B4 B5 B6

Equations: COST_OVR

MODEL Procedure

The Equation to Estimate is:

```
COST_OVR = F( B1(1), B2(FACTOR2), B3(FACTOR3), B4(FACTOR4),
              B5(FACTOR5), B6(FACTOR10) )
```

MODEL Procedure
OLS Estimation

OLS Estimation Summary

Dataset Option	Dataset
DATA=	FSCORES

Parameters Estimated	6

Minimization Summary

Method	GAUSS
Iterations	1

Final Convergence	Criteria
R	0
PPC	0
RPC(B1)	1119.312
Object	0.64395454
Trace(S)	0.01117022
Objective Value	0.0101699

Observations Processed

Read	67
Solved	67

MODEL Procedure
OLS Estimation

Nonlinear OLS Summary of Residual Errors

Equation	DF Model	DF Error	SSE	MSE	R-Square	Adj R-Sq
COST_OVR	6	61	0.6814	0.01117	0.3570	0.3043

Nonlinear OLS Parameter Estimates

Parameter	Estimate	Approx. Std Err	'T' Ratio	Approx. Prob>|T|
B1	0.113151	0.01291	8.76	0.0001
B2	0.053104	0.01301	4.08	0.0001
B3	0.023249	0.01301	1.79	0.0789
B4	0.026315	0.01301	2.02	0.0475
B5	0.030328	0.01301	2.33	0.0231
B6	0.027556	0.01301	2.12	0.0382

Number of Observations		Statistics for System	
Used	67	Objective	0.0102
Missing	0	Objective*N	0.6814

APPENDIX E

SELECTED PREDICTION CURVES

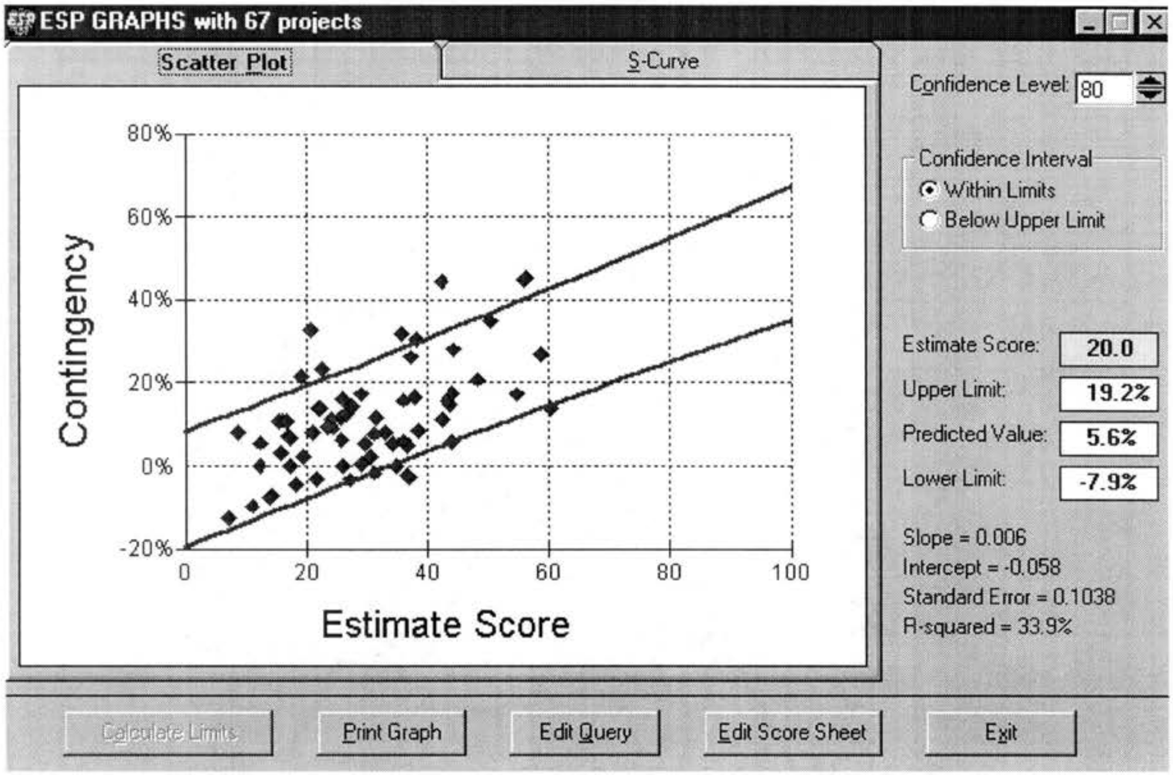


Figure 30 – Scatter Plot of All Sixty-Seven Projects

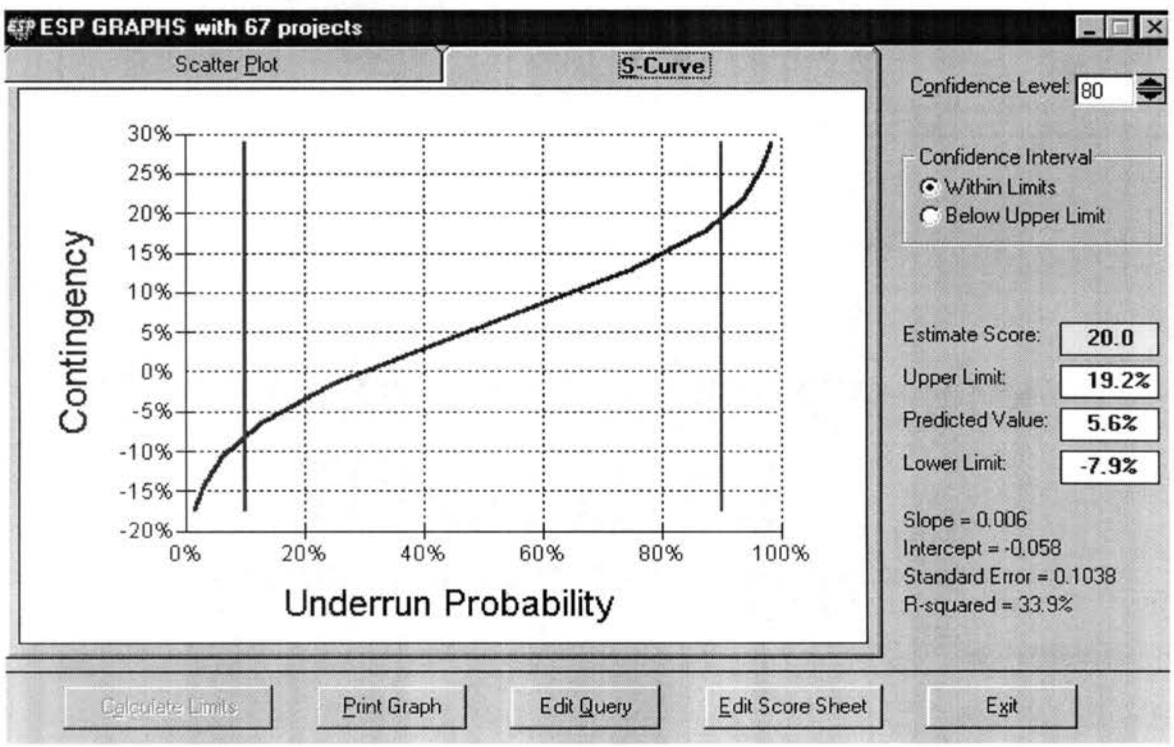


Figure 31 – Cumulative Distribution for All Sixty-Seven Projects
(Estimate Score = 20)

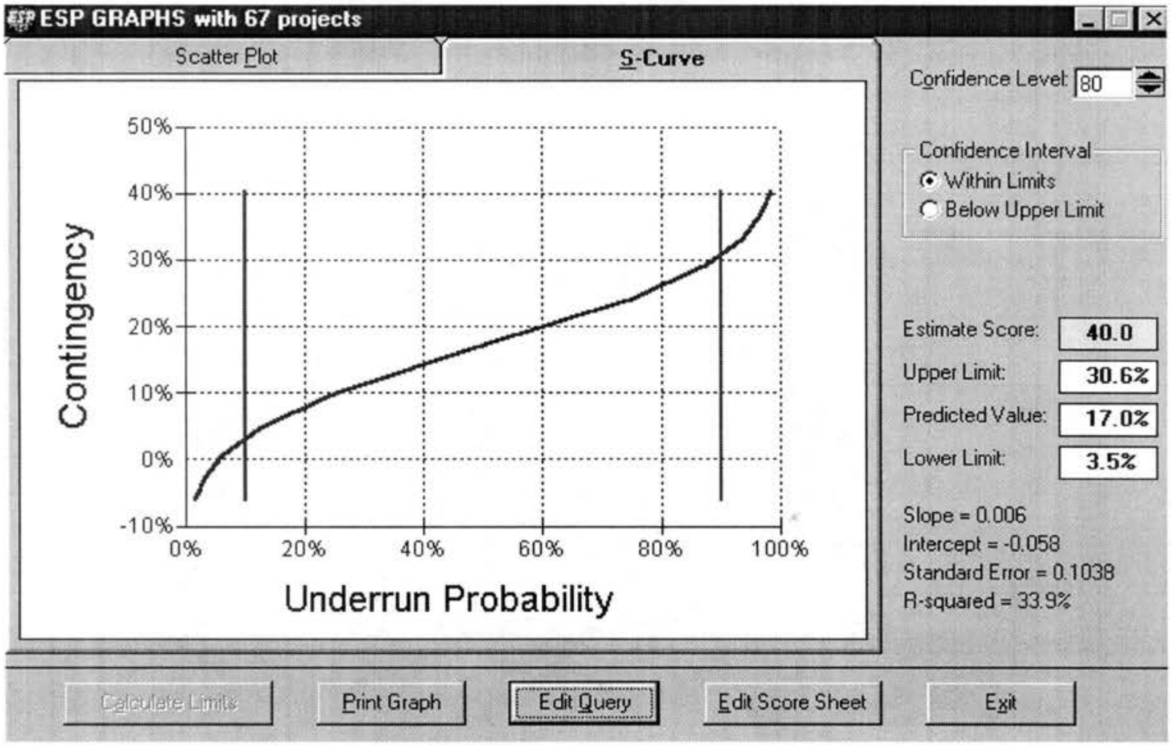


Figure 32 – Cumulative Distribution for All Sixty-Seven Projects
(Estimate Score = 40)

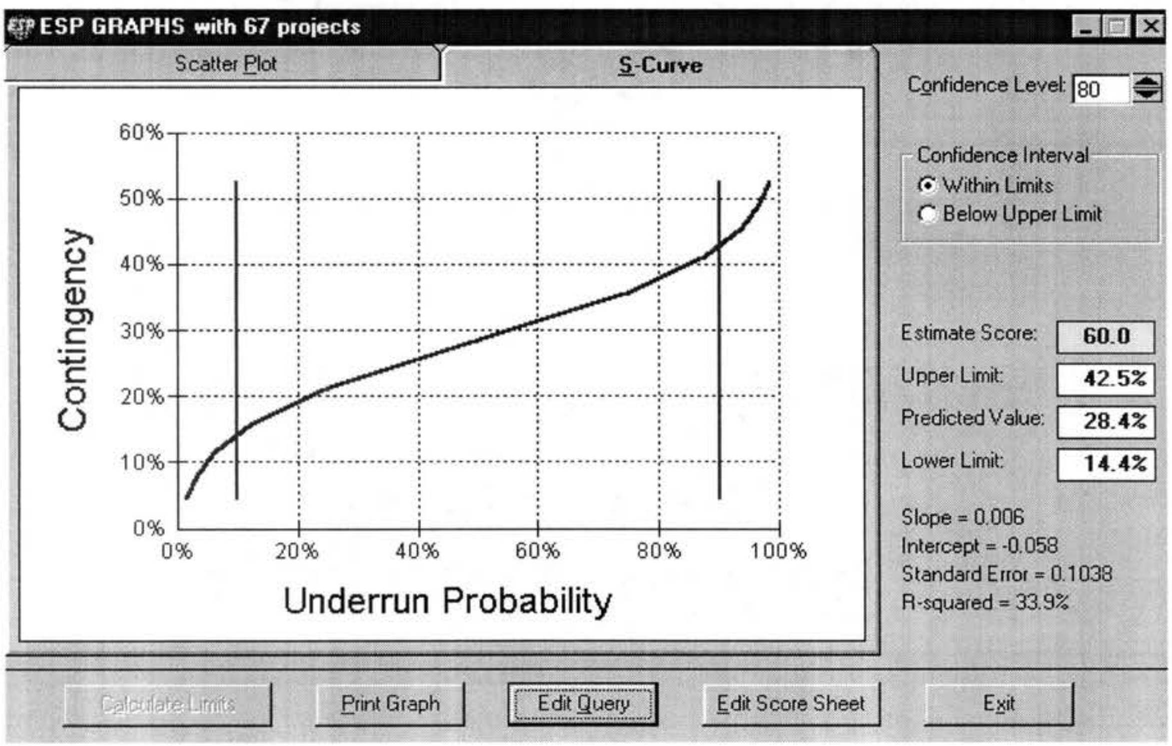


Figure 33 – Cumulative Distribution for All Sixty-Seven Projects
(Estimate Score = 60)

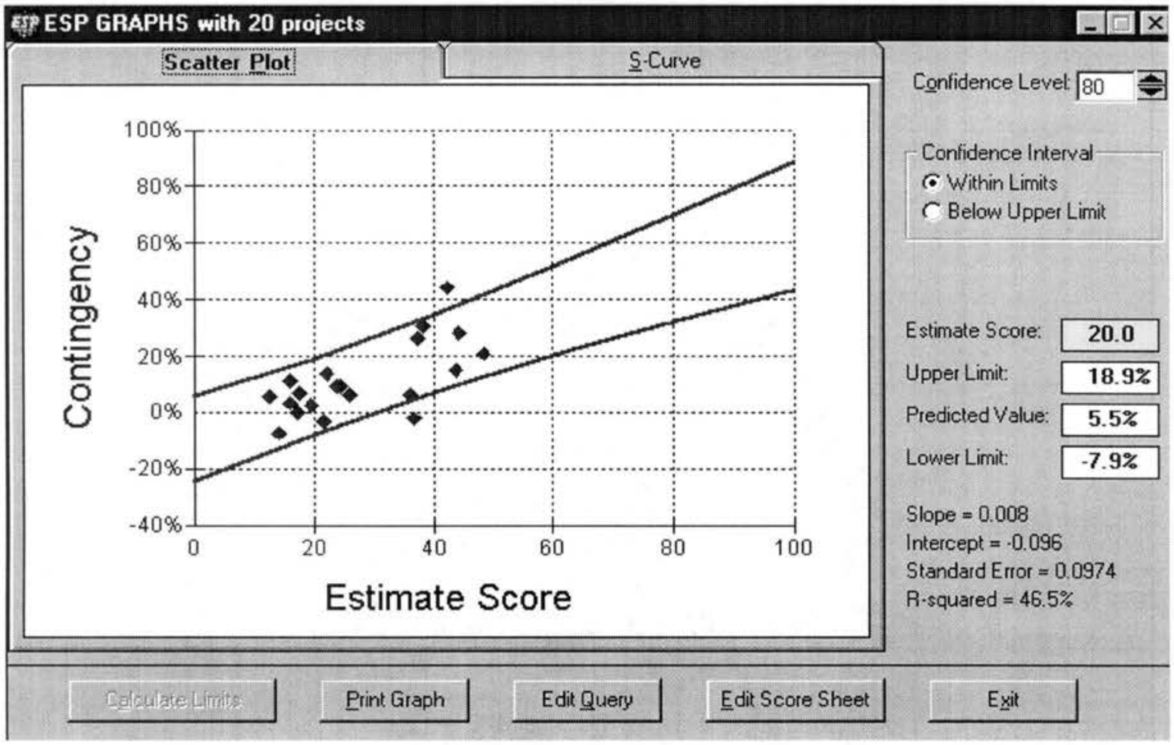


Figure 34 – Scatter Plot of Chemical Manufacturing Projects

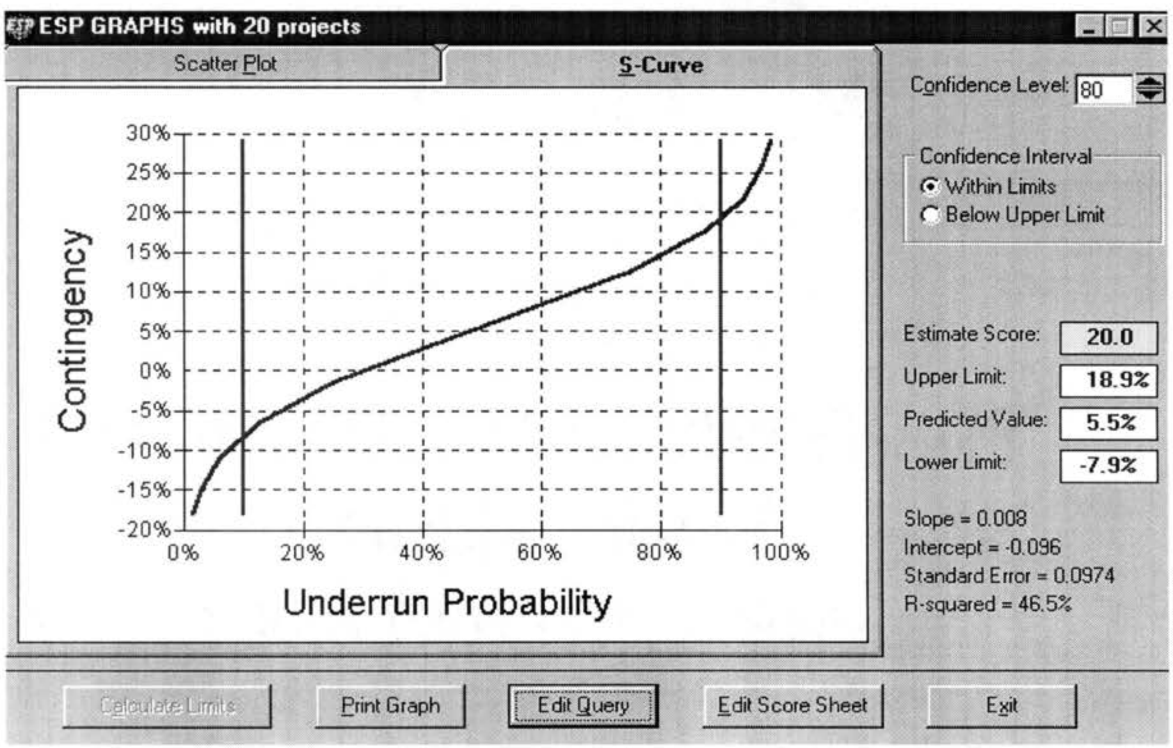


Figure 35 – Cumulative Distribution for Chemical Manufacturing Projects
(Estimate Score = 20)

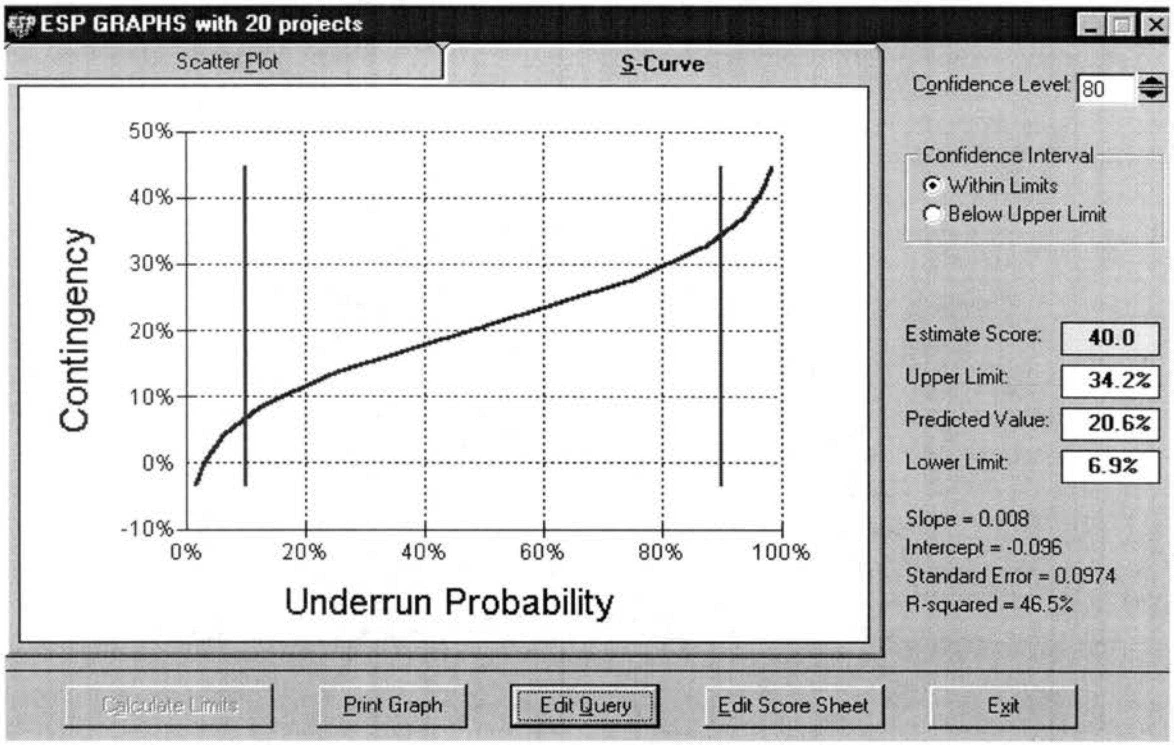


Figure 36 – Cumulative Distribution for Chemical Manufacturing Projects
(Estimate Score = 40)

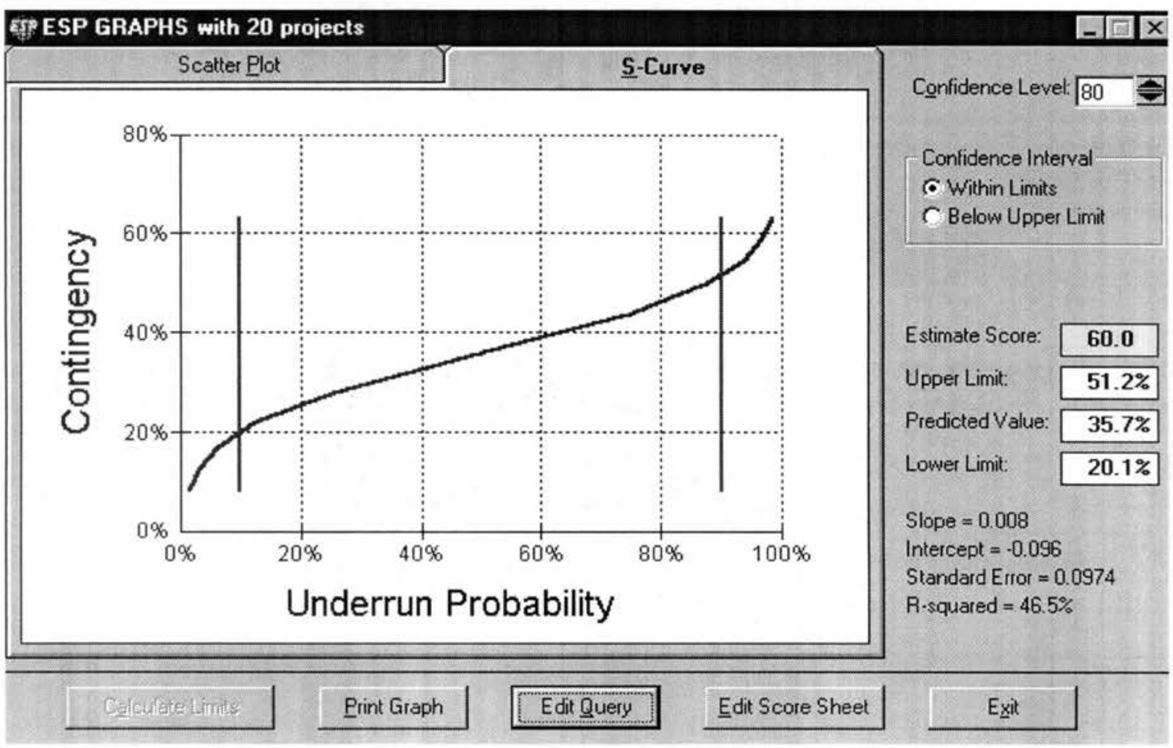


Figure 37 – Cumulative Distribution for Chemical Manufacturing Projects
(Estimate Score = 60)

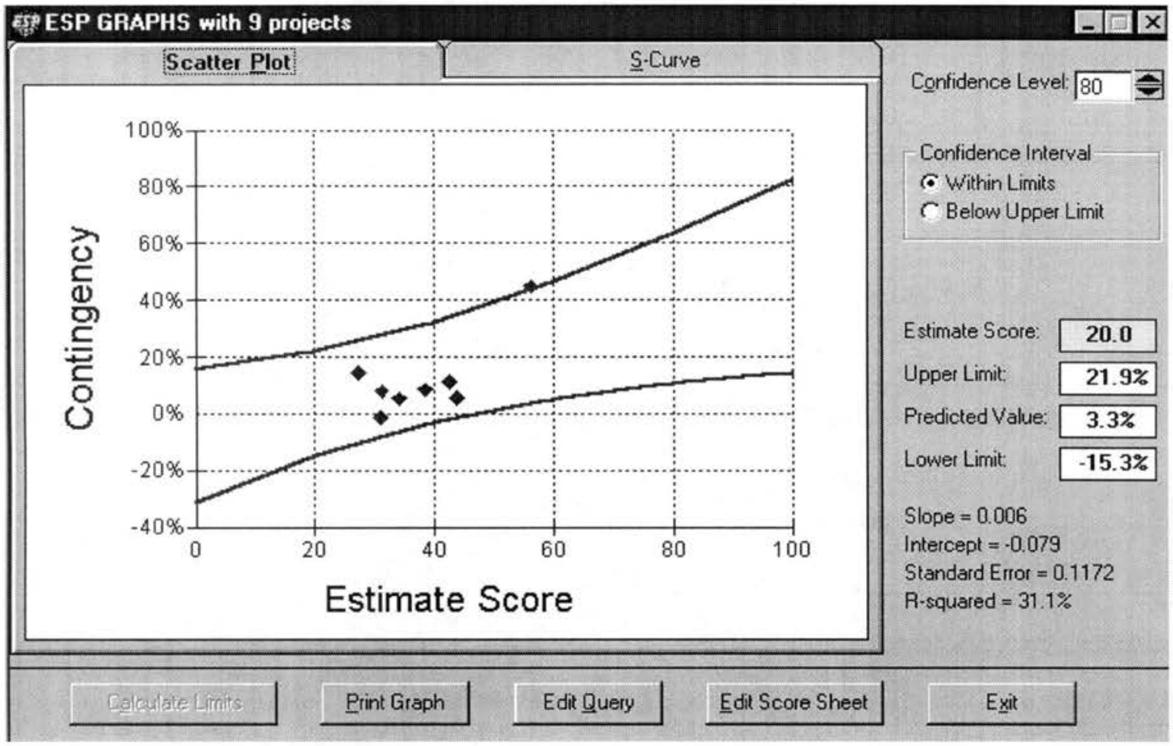


Figure 38 – Scatter Plot for Electrical Generation Projects

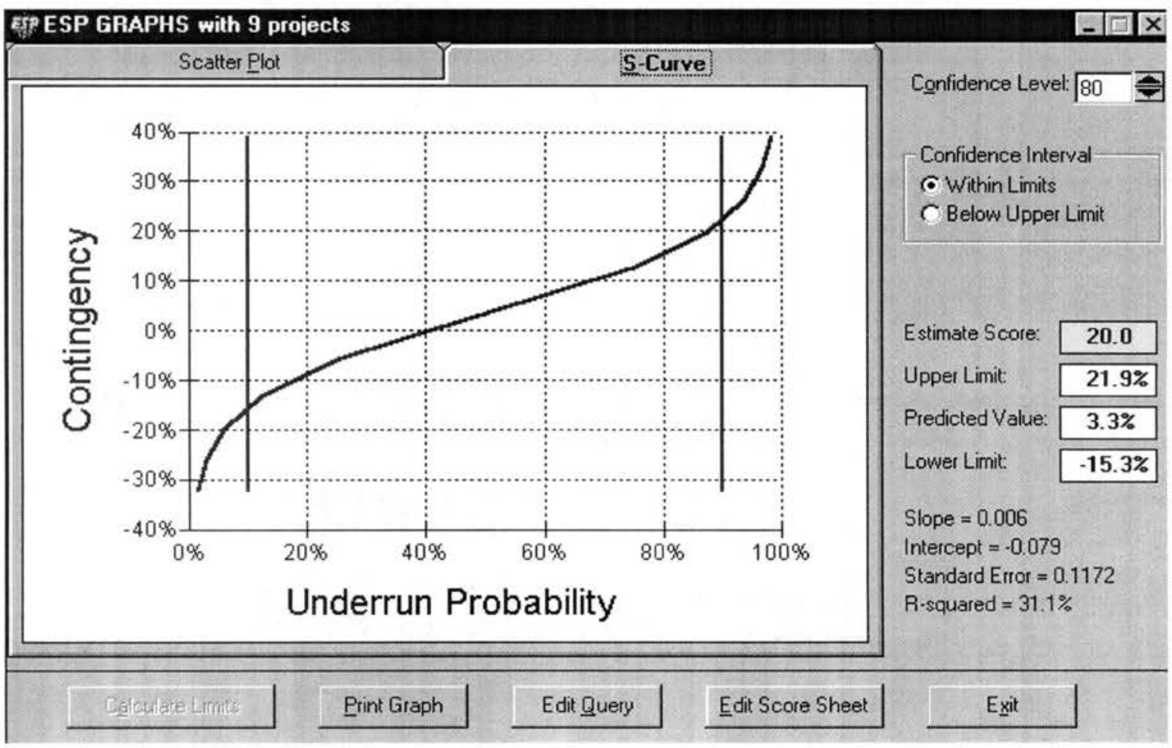


Figure 39 – Cumulative Distribution for Electrical Generation Projects
(Estimate Score = 20)

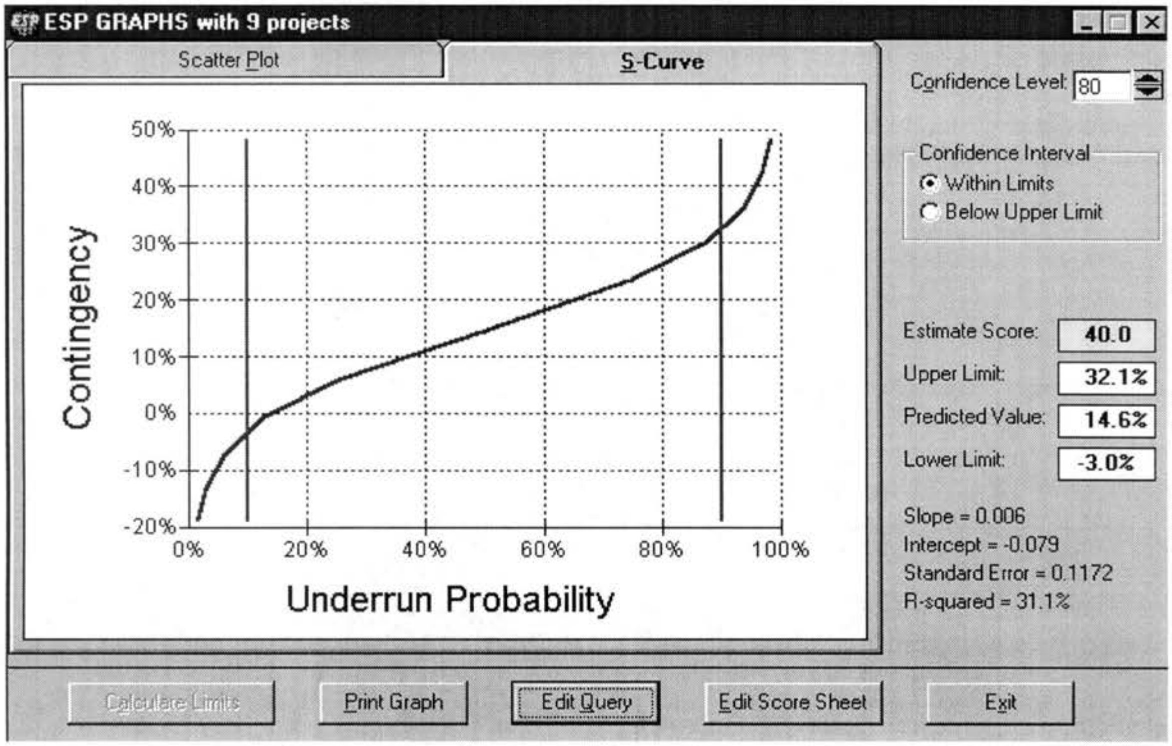


Figure 40 – Cumulative Distribution for Electrical Generation Projects
(Estimate Score = 40)

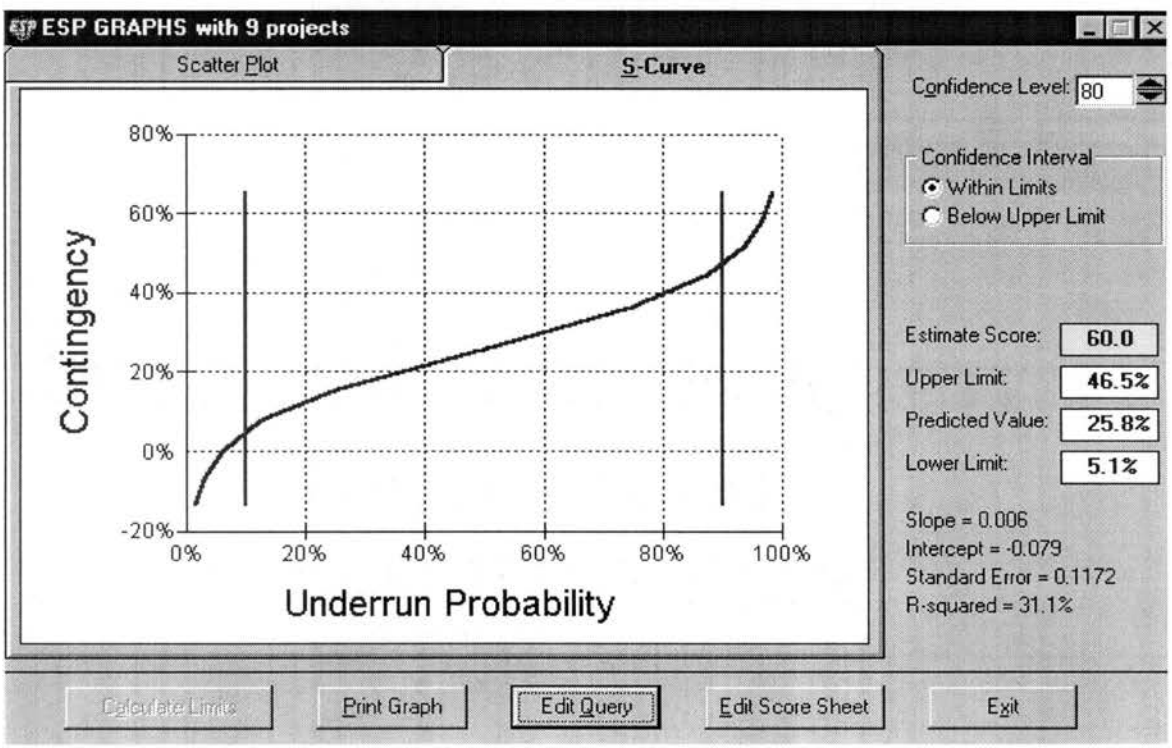


Figure 41 – Cumulative Distribution for Electrical Generation Projects
(Estimate Score = 60)

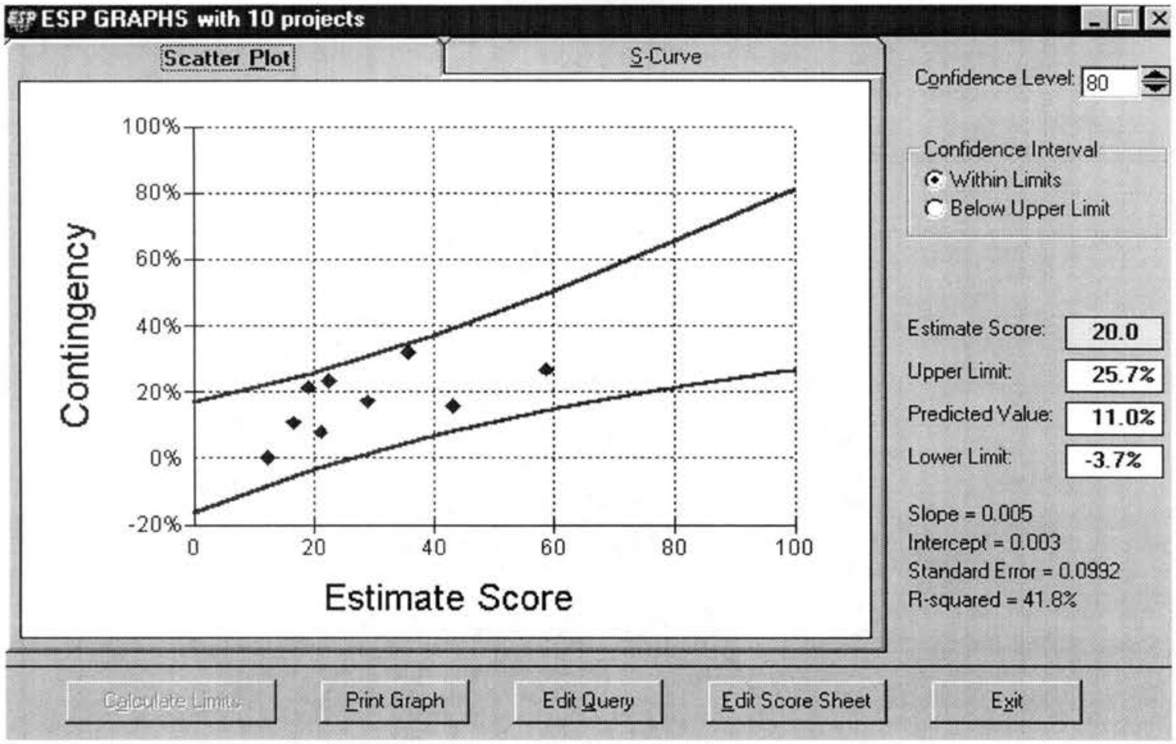


Figure 42 – Scatter Plot for Oil Refining Projects

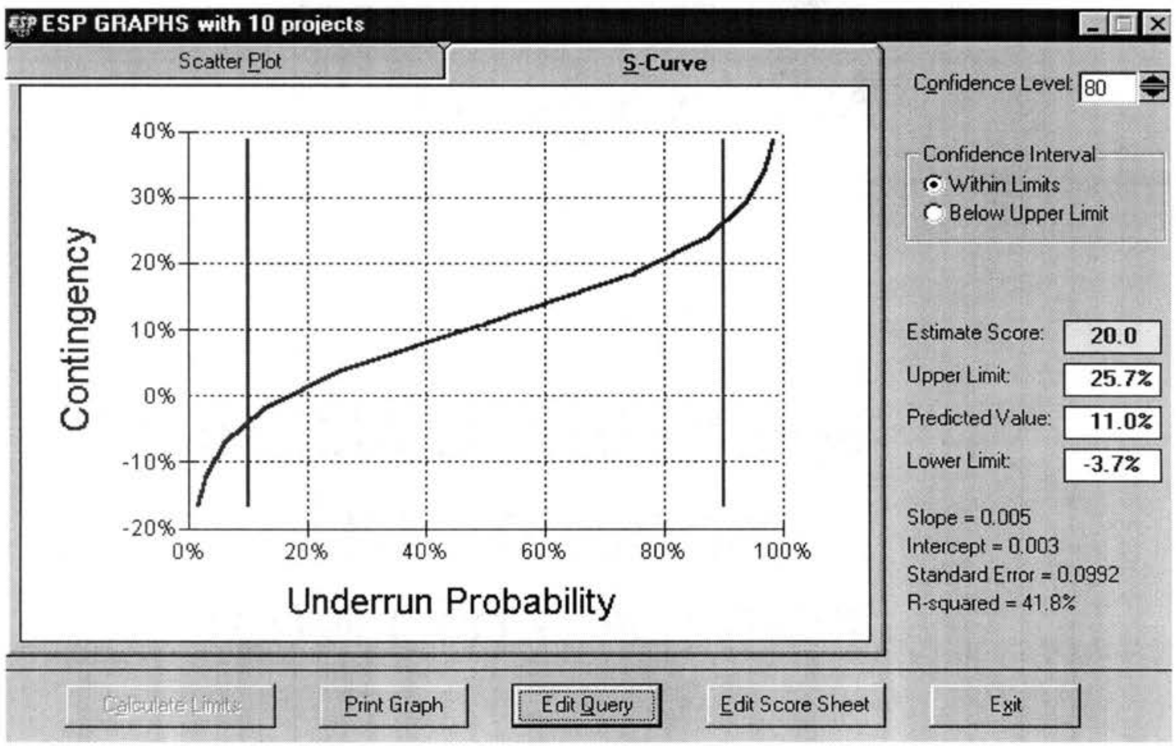


Figure 43 – Cumulative Distribution for Oil Refining Projects
(Estimate Score = 20)

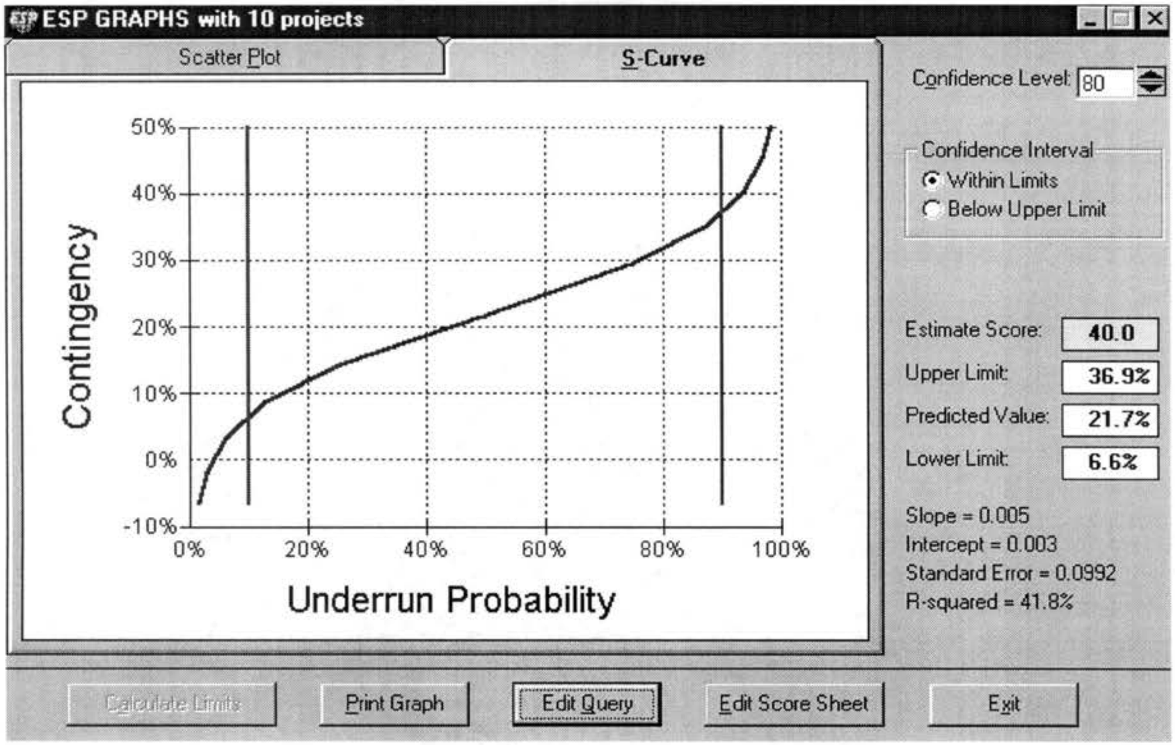


Figure 44 – Cumulative Distribution for Oil Refining Projects
(Estimate Score = 40)

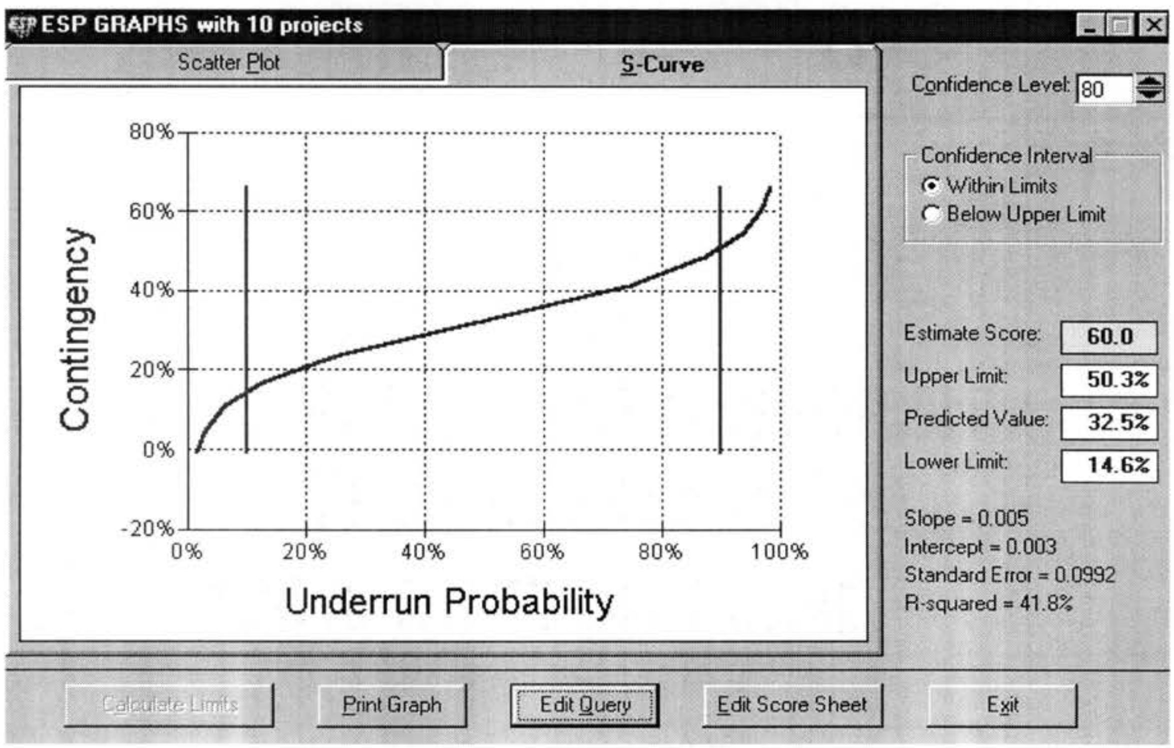


Figure 45 – Cumulative Distribution for Oil Refining Projects
(Estimate Score = 60)

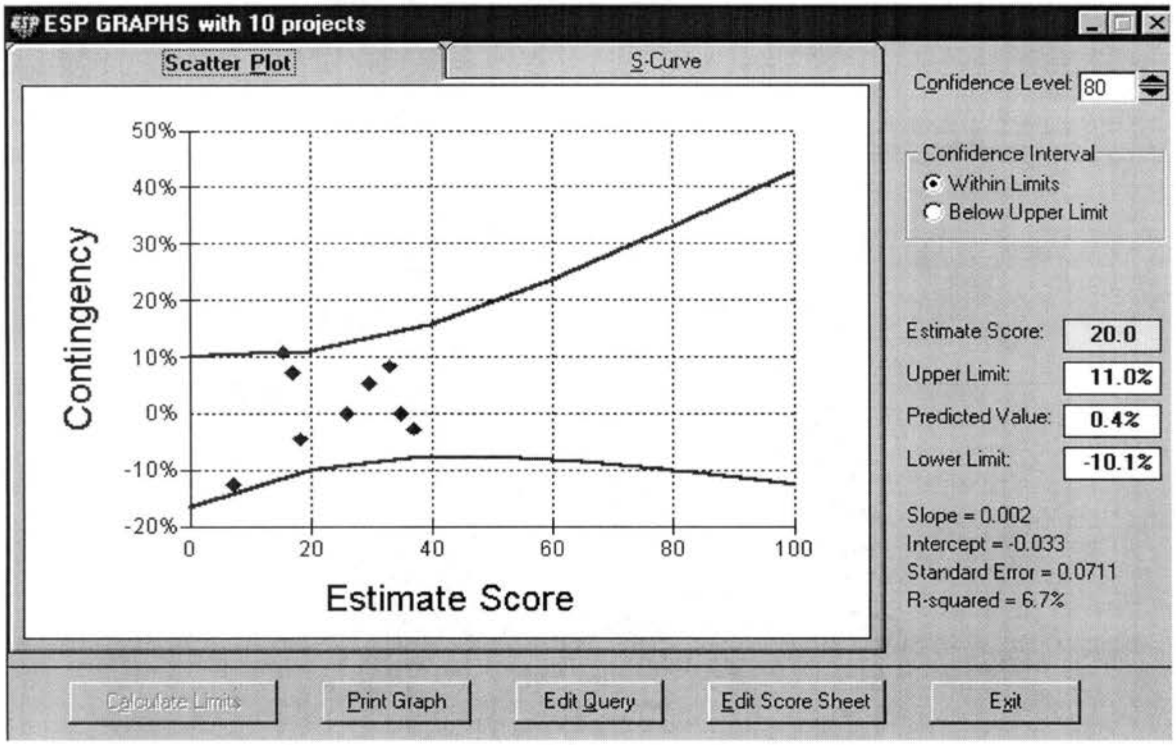


Figure 46 – Scatter Plot for Pulp and Paper Projects

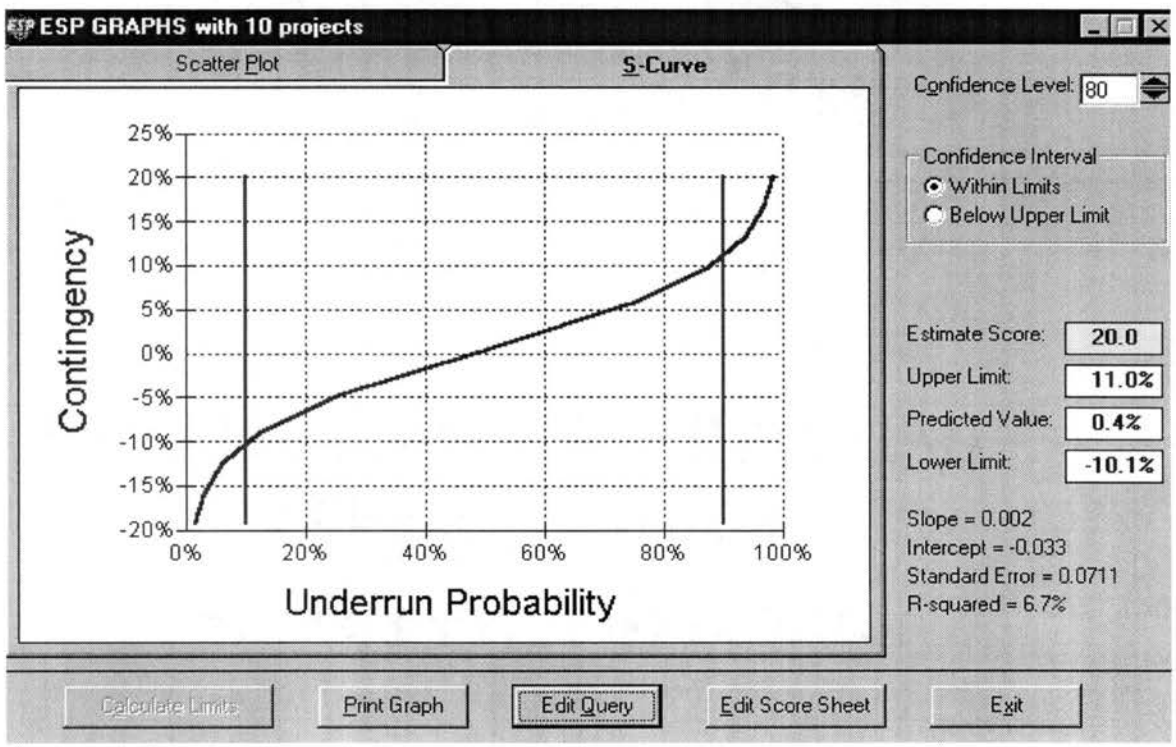


Figure 47 – Cumulative Distribution for Pulp and Paper Projects
(Estimate Score = 20)

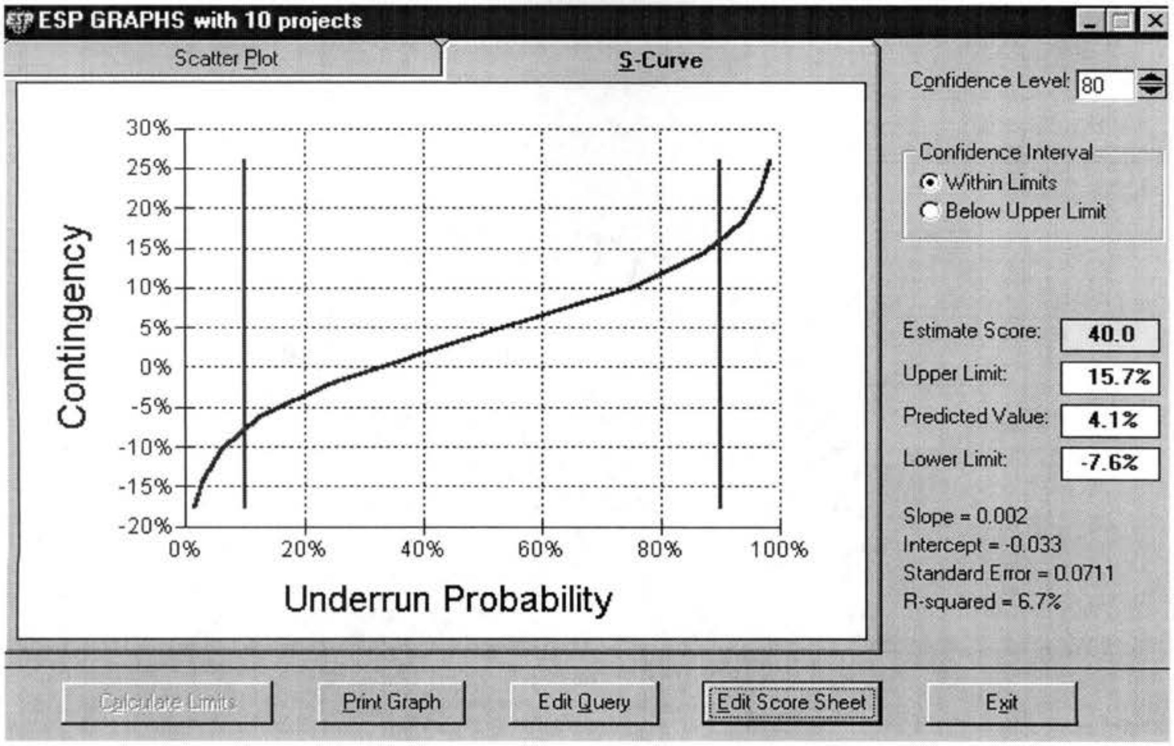


Figure 48 – Cumulative Distribution for Pulp and Paper Projects
(Estimate Score = 40)

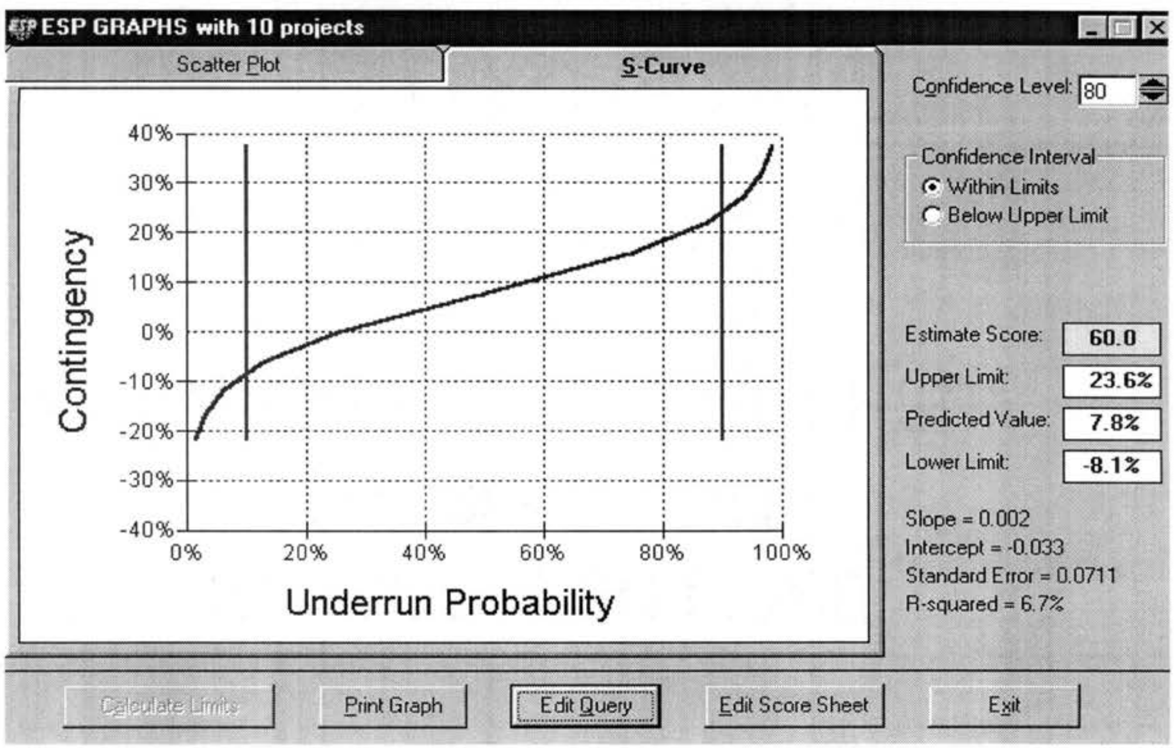


Figure 49 – Cumulative Distribution for Pulp and Paper Projects
(Estimate Score = 60)

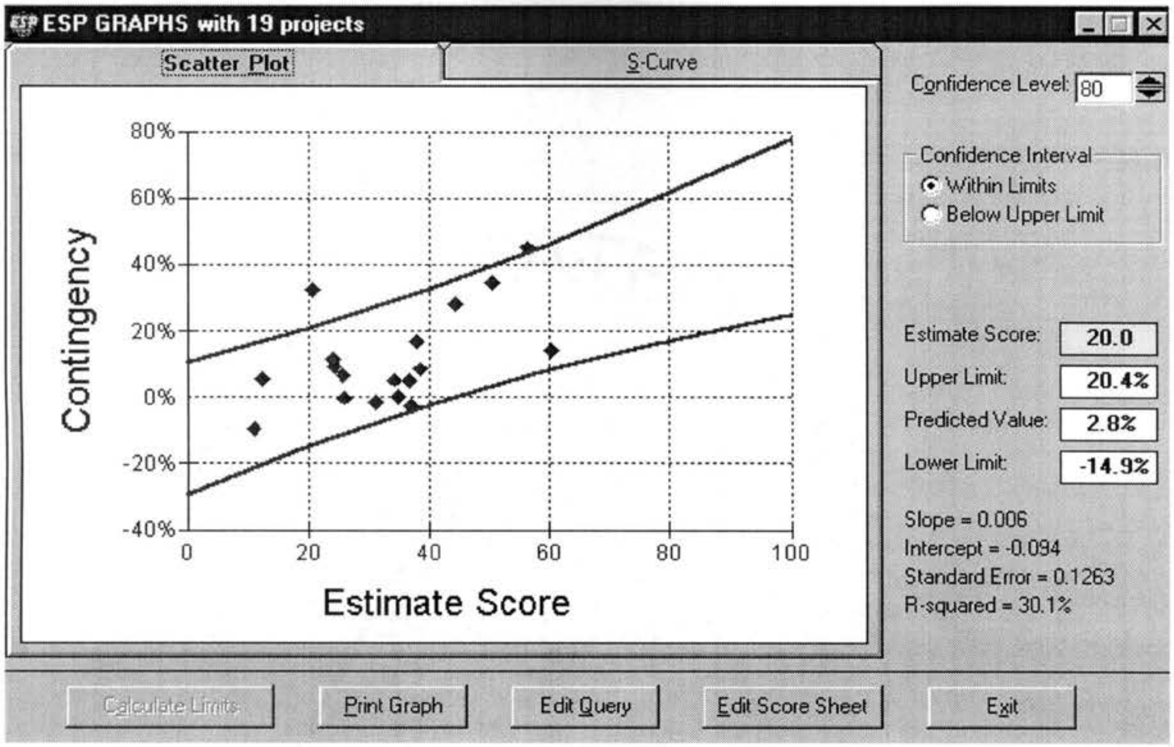


Figure 50 – Scatter Plot for Add-On and Modernization Projects

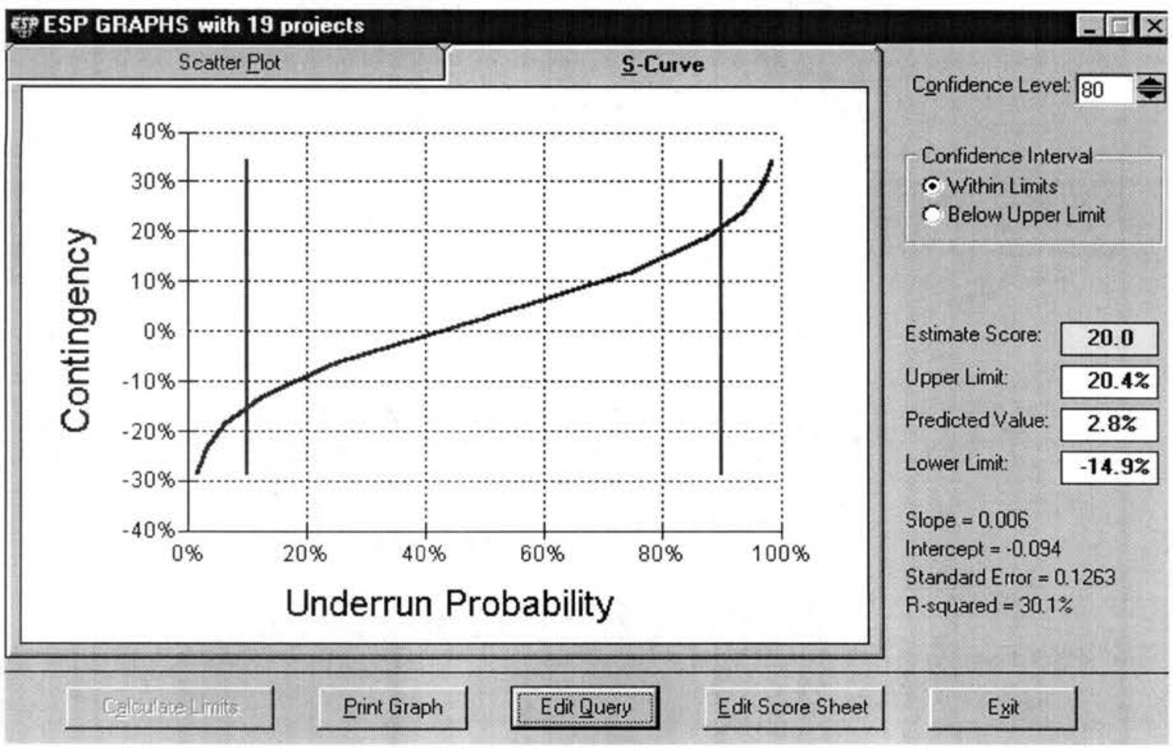


Figure 51 – Cumulative Distribution for Add-On and Modernization Projects
(Estimate Score = 20)

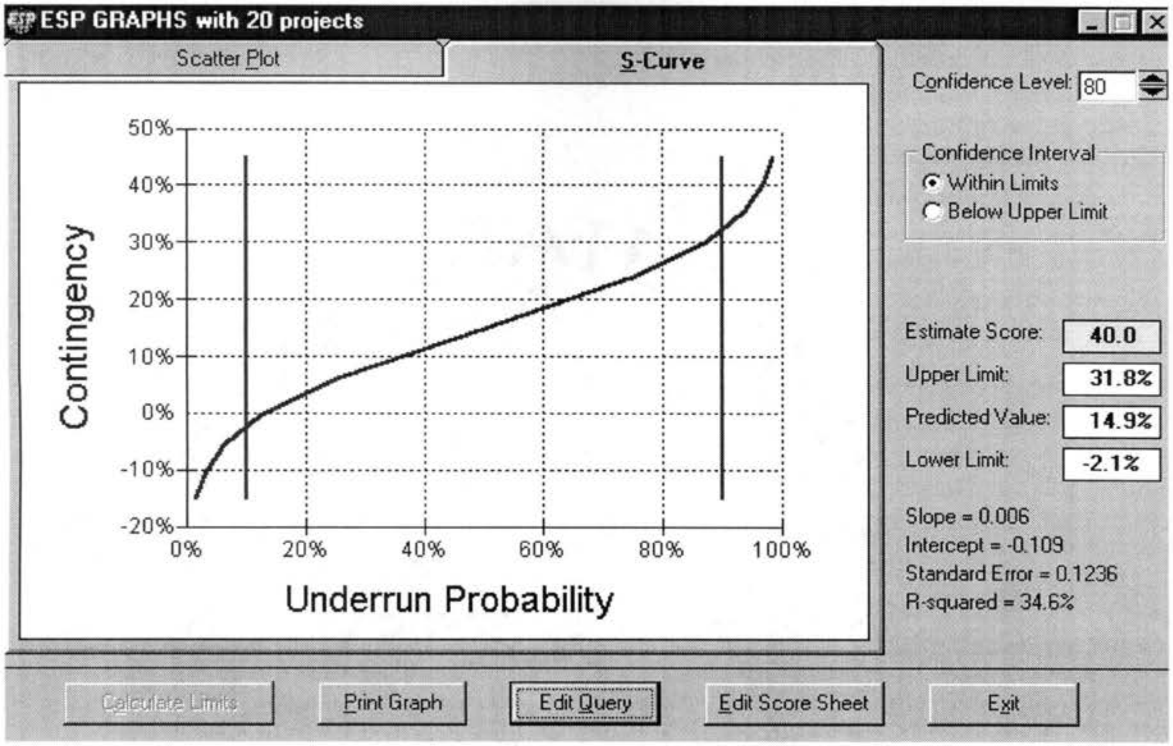


Figure 52 – Cumulative Distribution for Add-On and Modernization Projects
(Estimate Score = 40)

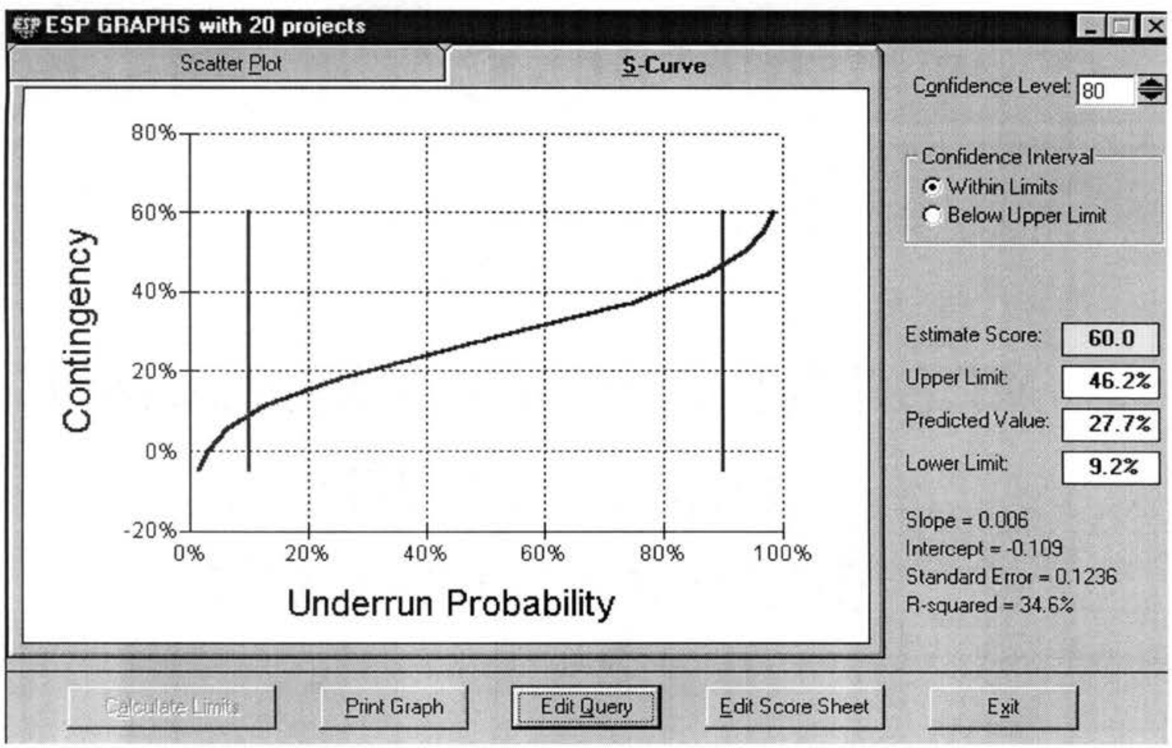


Figure 53 – Cumulative Distribution for Add-On and Modernization Projects
(Estimate Score = 60)

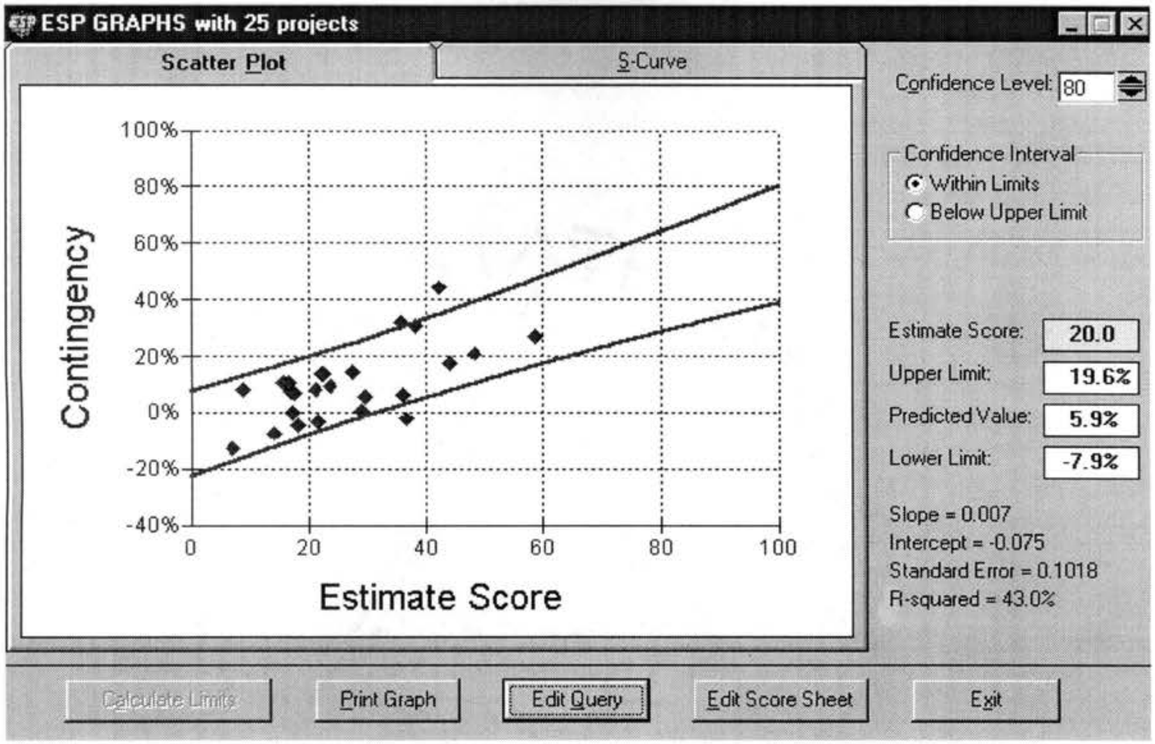


Figure 54 – Scatter Plot for Conversion Projects

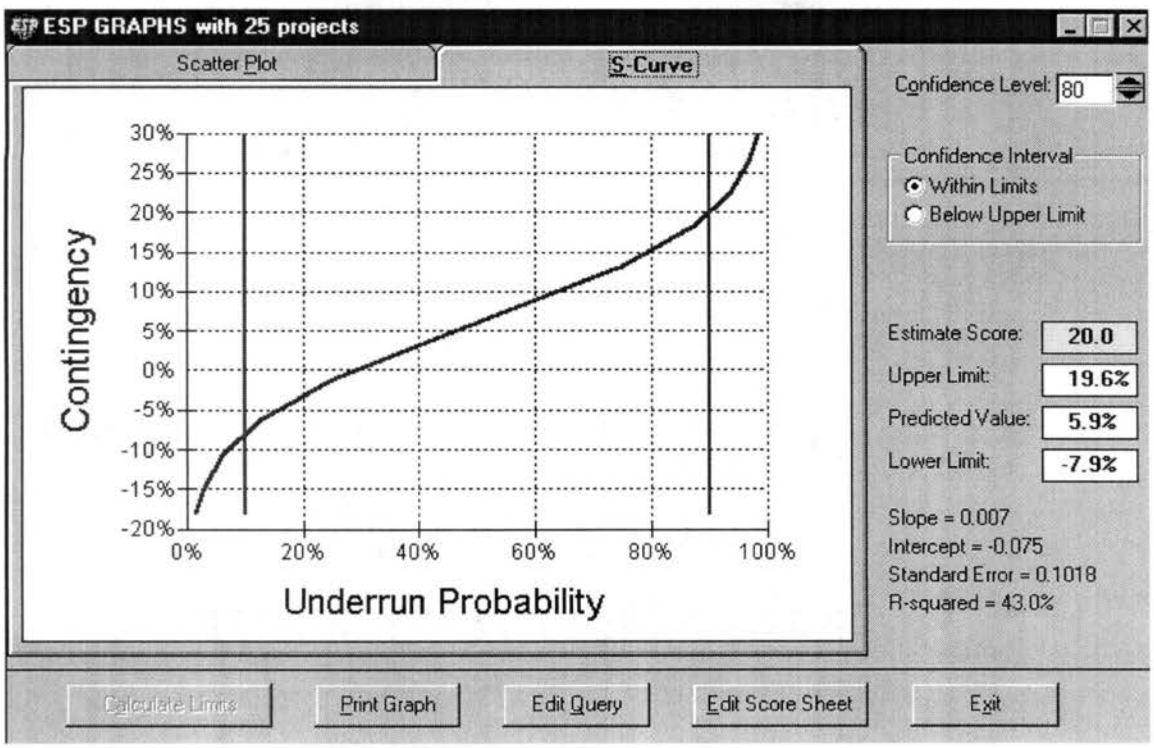


Figure 55 – Cumulative Distribution for Conversion Projects
(Estimate Score = 20)

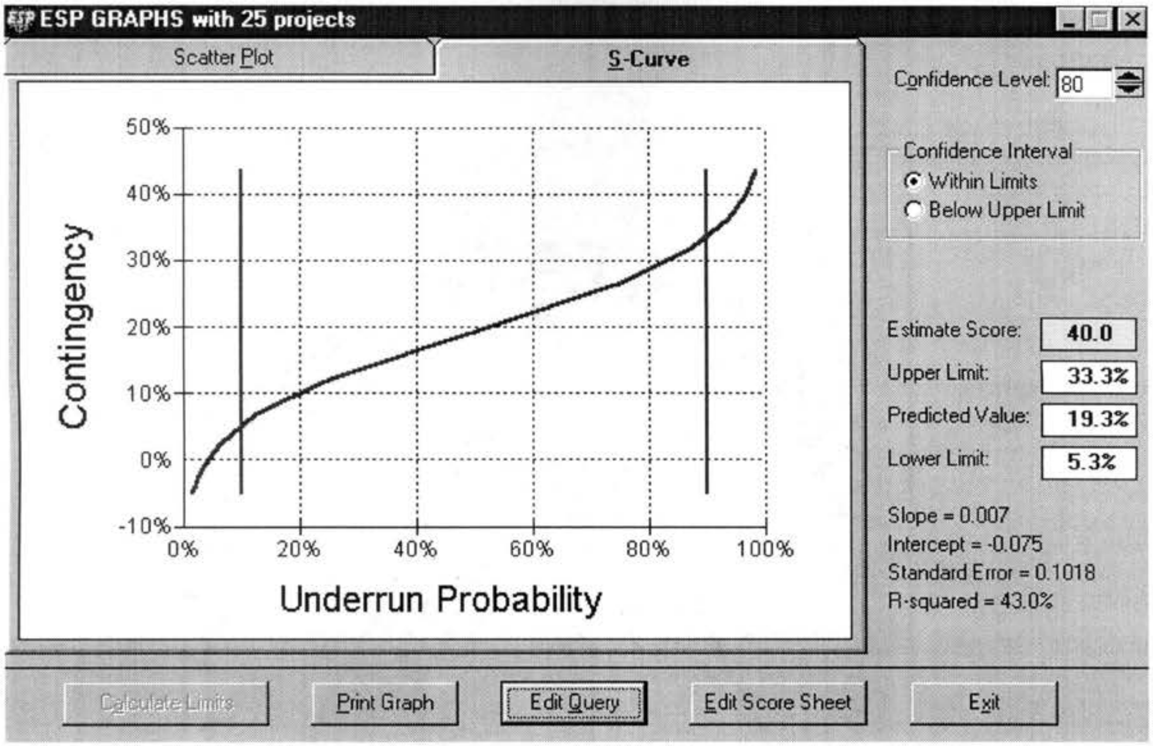


Figure 56 – Cumulative Distribution for Conversion Projects
(Estimate Score = 40)

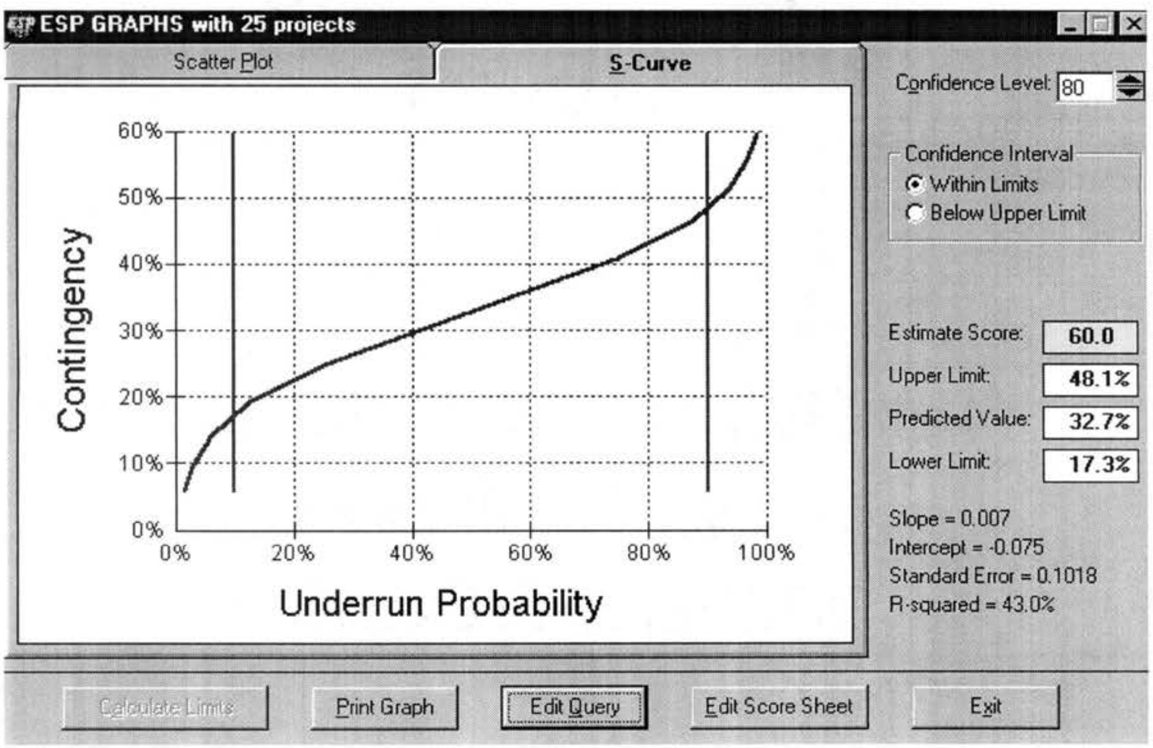


Figure 57 – Cumulative Distribution for Conversion Projects
(Estimate Score = 60)

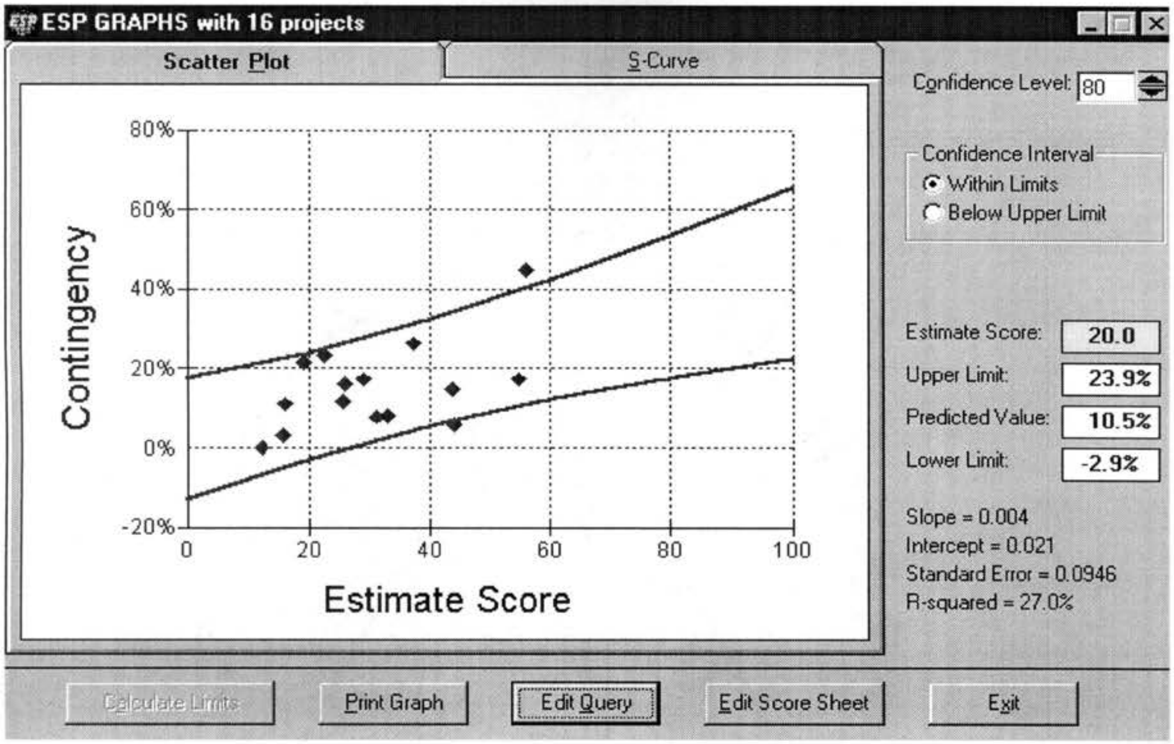


Figure 58 – Scatter Plot for Grass Roots Projects

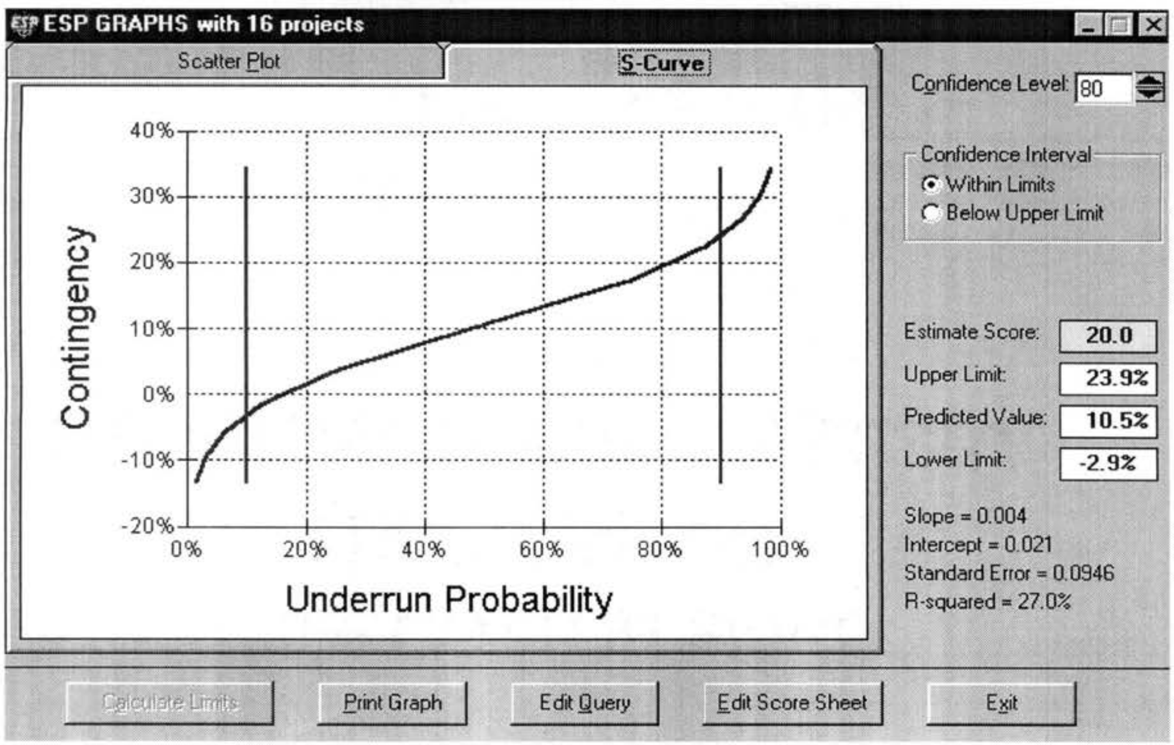


Figure 59 – Cumulative Distribution for Grass Roots Projects
(Estimate Score = 20)

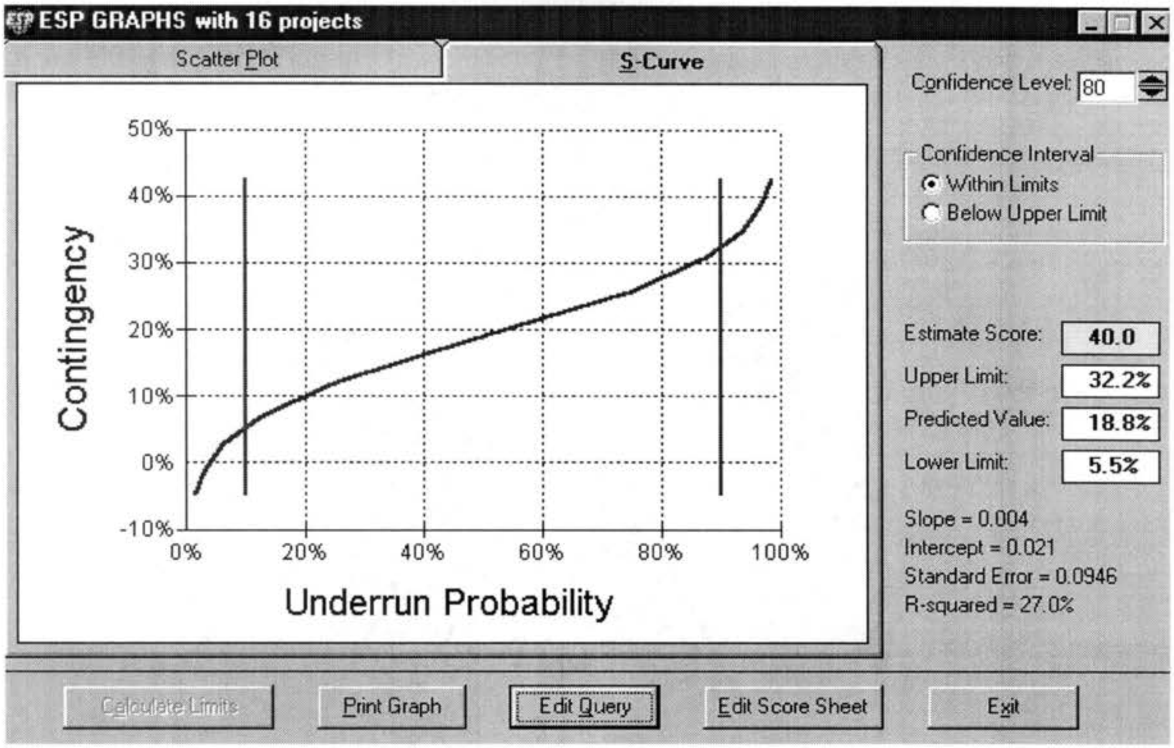


Figure 60 – Cumulative Distribution for Grass Roots Projects
(Estimate Score = 40)

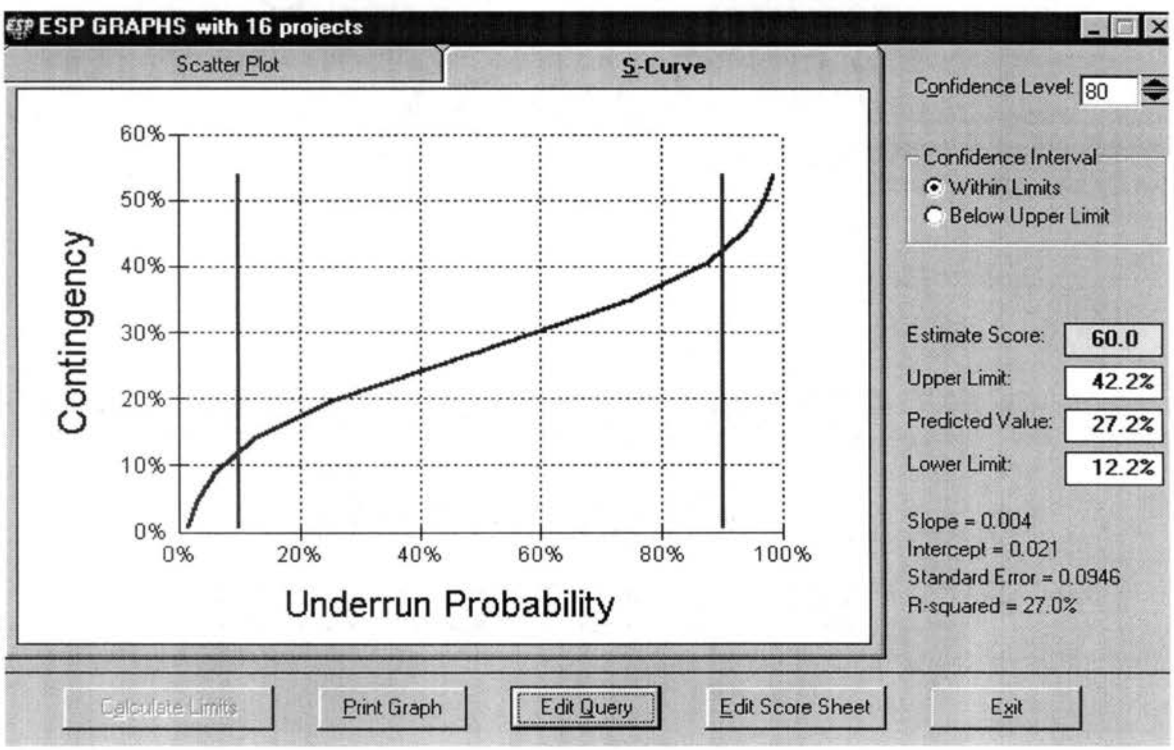


Figure 61 – Cumulative Distribution for Grass Roots Projects
(Estimate Score = 60)

APPENDIX F

ESP GUIDE

TABLE OF CONTENTS

LIST OF FIGURES

PAGE

Section 1: Introduction: The Estimate Score and ESP

Welcome to the Estimate Score Program (ESP) for Windows. ESP was developed by the "Improving Early Estimates" research team of the Construction Industry Institute as a tool to enhance the accuracy of early estimates. ESP assimilates the historical performance of many previous estimates to predict and improve the accuracy of early estimates. To accomplish this endeavor, ESP uses another tool developed by the "Improving Early Estimates" research team, the Estimate Score.

The Estimate Score functions as a tool for measuring how well an estimate has been prepared for a particular project. The Estimate Score assists the user in identifying the accuracy range of an estimate and, in so doing, reduces the subjectivity involved in preparing and utilizing early estimates.

The accuracy of an early estimate depends on four determinants: ***who*** is involved in preparing the estimate, ***how*** the estimate is prepared, ***what*** is known about the project, and ***other factors*** that can influence the cost of a project. The Estimate Score was created to rate the estimate based on these determinants and is organized into four main divisions, one for each determinant. Each division is further broken down into elements. The individual elements that comprise each division are listed and defined in the Appendix. Figure 62 graphically depicts the process of using the four determinants to improve early estimates.

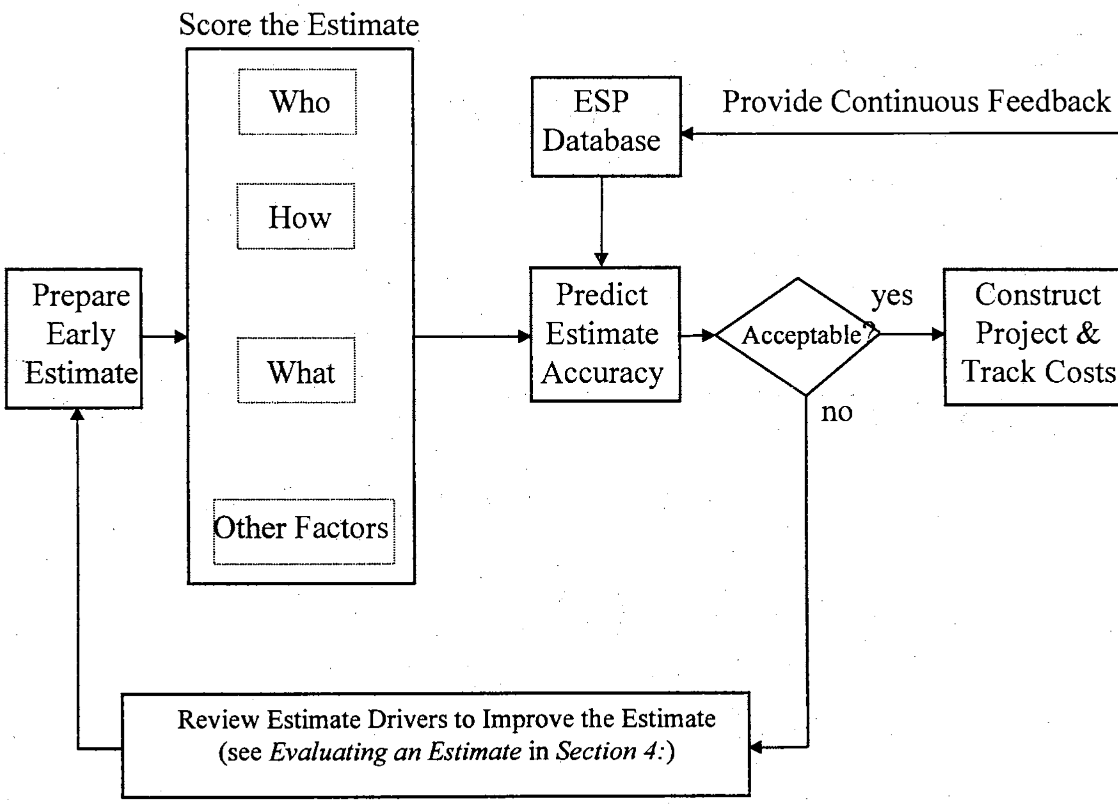


Figure 62–Using the Four Determinants of Estimate Accuracy to Improve Early Estimates

Section 2: Why Use ESP?

The following questions and answers illustrate the usefulness of the Estimate Score and ESP:

- **What is the purpose of the Estimate Score?**
  The Estimate Score is a tool for measuring how well an estimate has been prepared for a particular project. It provides a "reality-check" on the estimate for better decision making by the business unit and the project team.

- **What is The Estimate Score Program (ESP)?**
  The Estimate Score Program (ESP) is a computer software package developed by the "Improving Early Estimates" research team to implement and automate the Estimate Score procedure. ESP runs on Windows 3.x, Windows 95 or Windows NT.

- **How is ESP used?**
  After an early estimate is completed, the user can run ESP to "score" the estimate. The score is based on rating each of the 45 elements that can have a significant impact on the accuracy of an early estimate.

- **What can be done with ESP?**
  ESP can be utilized to calculate an Estimate Score and then:
  - compare the Estimate Score with the scores of other similar projects
  - determine the probability of a predicted level of cost overrun
  - determine the probability of a predicted level of cost underrun
  - determine the confidence level for a desired cost range (upper and lower limit)
  - determine the cost range (upper and lower limit) for a desired confidence level
  - determine the amount of "contingency" to be applied to the base estimate

- **How can ESP benefit the business unit and the project team?**
  ESP provides better information for decision-making and improves alignment between the business unit and the project team by providing a framework for better understanding the estimate as well as the factors that can influence the accuracy of an early estimate. The user can query the database to compare the score of a particular estimate with the scores of other similar projects. In addition, ESP provides a quantitative method for determining the amount of contingency that should be applied to an estimate based on the Estimate Score and its relation to the historical outcomes of other projects in the database.

Section 3: Installing ESP

Installing from Floppy Disks

To install ESP locally from floppy disk:

1. Insert the disk labeled "ESP Setup Disk" in the drive and run (from the Program Manager in Windows 3.x) or double-click (from Windows Explorer in Windows 95) the "SETUP.EXE" file.
2. Follow the on-screen instructions to complete the installation.

Installing from the Internet

To install ESP locally from the internet:

1. Download the file "ESPZIP.EXE" to a temporary directory on the hard drive.
2. Run (from the Program Manager in Windows 3.x) or double-click (from Windows Explorer in Windows 95) the "ESPZIP.EXE" file to initiate the self-extraction.
3. Double-click the "SETUP.EXE" file that was extracted from the previous procedure.
4. Follow the on-screen instructions to complete the installation.

Installing on a Network

To install ESP on a network:

1. Perform Step 1 of *Installing from Floppy Disks* or Steps 1 – 3 of *Installing from the Internet* to initiate the network installation process.
2. Click the <Change Directory> command button when the second setup form appears.
3. Select the desired location on the network drive for ESP. (The ESP application, database and help files will be stored in this location for all users.)
4. Follow the on-screen instructions to complete the network portion of the installation.
5. Perform Steps 1 – 2 of *Installing from Floppy Disks* using the disk labeled "ESP Workstation Setup Disk" or Steps 1 – 4 of *Installing from the Internet* using the "ESPWSZIP.EXE" file to perform the workstation portion of the installation.
6. For Windows 95 and Windows NT: After the "ESP" program folder appears, click *File*, then *New* and then *Shortcut* from the program folder's pull-down menu. Click the <Browse…> command button, locate the ESP application file ("ESP.exe"), then click <Next> and then <Finish>.

Running ESP

To launch ESP, double-click the ESP icon from the ESP program folder.

Section 4: Navigating the Forms and Tabs of ESP

Figure 63 gives a graphical representation of the forms and tabs that make up ESP. Three primary forms (Estimate Score Sheet, Query and Graphs) contain the majority of ESP's functionality. Once ESP has been launched, the Estimate Score Sheet form is displayed. However, either of the other two primary forms can be reached with the click of a button. In fact, all of the three primary forms can launch either of the other two primary forms with a single button-click. Two of the primary forms (Estimate Score Sheet and Graphs) contain tabs which enable the user to view additional information. The Query form can be utilized to launch a secondary form (Statistics). The Statistics form can only be accessed from the Query form and returns only to the Query form.

See Figure 70 for a graphical representation of the commands that are available from each of the forms of ESP.

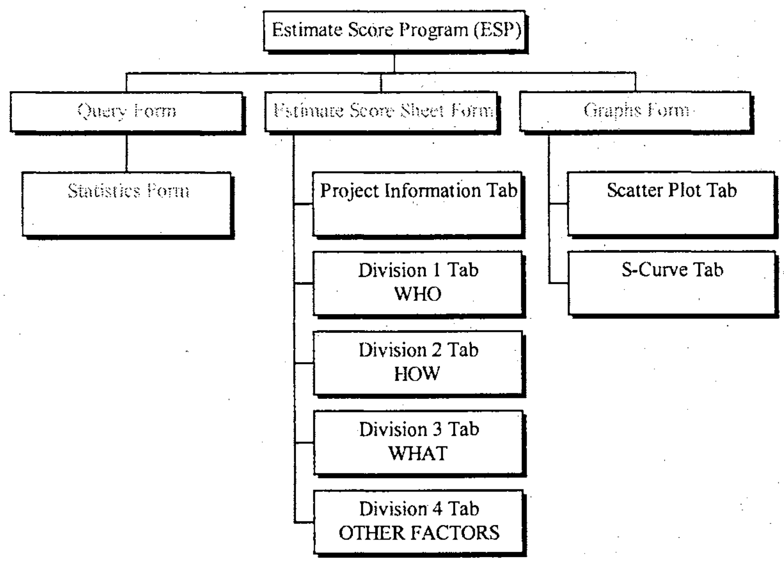


Figure 63–Breakdown of ESP Forms and Tabs

Estimate Score Sheet form

The Estimate Score Sheet form functions as the input center for ESP. The Estimate Score Sheet form enables the user to enter data as well as process data from ESP's database. The Estimate Score Sheet form contains five tabs (Project Info, Division 1, Division 2, Division 3 and Division 4).

Project Info tab

The upper portion of the Project Info tab, as shown in Figure 64, allows the user to input and edit descriptive information about the project and the project estimate as follows:

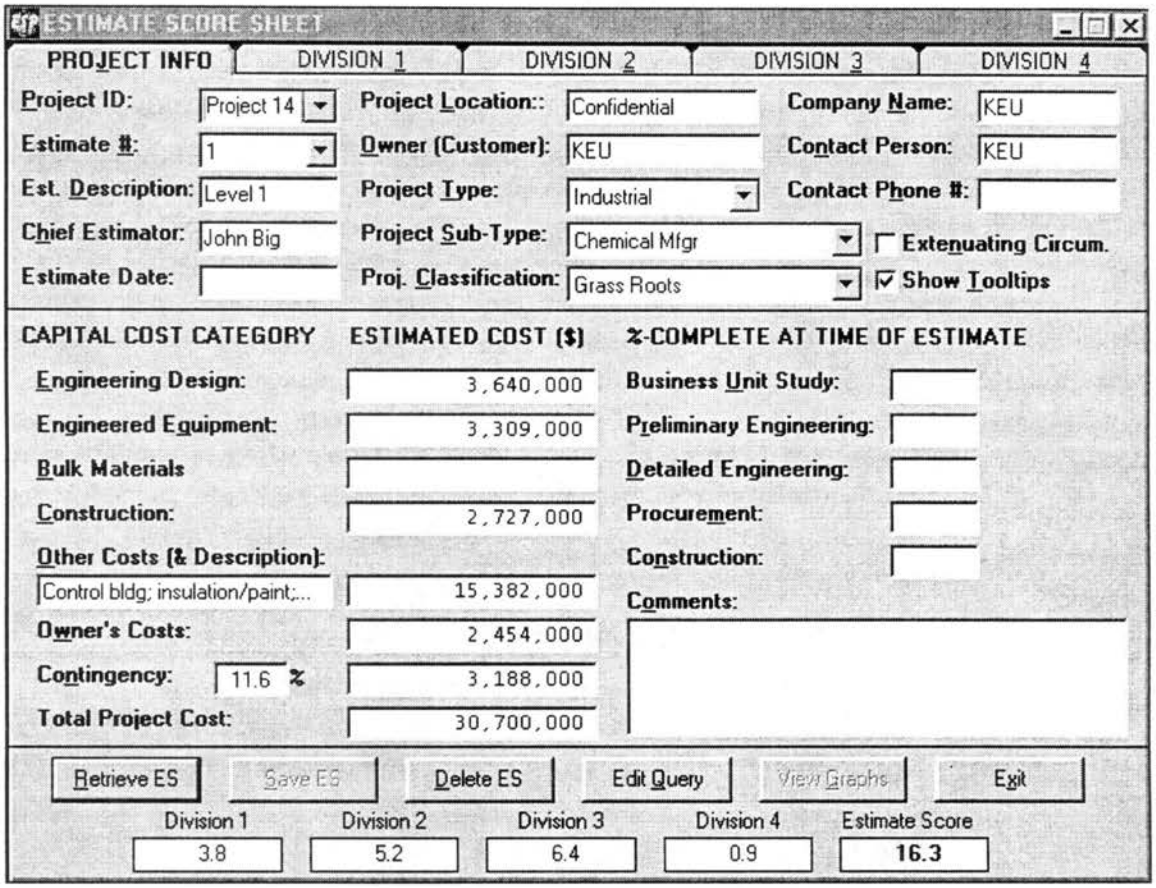


Figure 64–Estimate Score Sheet Form (Project Info Tab)

- *Project ID*: Click the small arrow on this box to display a drop-down list of all the completed as well as the ongoing projects currently stored in the database. Simply select the desired project from the list. If the desired project has not yet been stored in the database, type the project's identifier in the box and press <Tab>.

- *Estimate #:* After the desired project has been selected or entered in the <Project ID> box, click the small arrow on this box to display a drop-down list of all the estimates that have been stored for the project. (ESP tracks estimates for a given project according to the sequential order in which they were entered.) Select the desired estimate (or "New Estimate" if the desired estimate is not listed or if no estimate has yet been stored for the project). If "New Estimate" is selected, ESP will ask if the "New Estimate" will be "Actual Costs". Responding to this question with a "Yes" will treat the cost data entered in the lower portion of the Project Info tab as actual cost data rather than estimated costs. In addition, the Division tabs will remain disabled since actual cost information will not need a corresponding Estimate Score. Once the desired estimate has been selected, click the <Retrieve ES> command button at the bottom of the form. See *Section 4: **Error! Not a valid bookmark self-reference.*** for descriptions of the command buttons.

- *Estimate Description*: Describe the type of estimate that was performed (class 1, level 3, approved for design (AFD), budgetary, etc.).
- *Chief Estimator*: Enter the name of the person primarily responsible for the estimate.
- *Estimate Date*: Enter the date the estimate was completed or submitted. NOTE: This box will be labeled Completion Date if actual cost data are being recorded. As such, enter the actual completion date for the project.
- *Project Location*: Enter the project location.
- *Owner (Customer)*: Enter the name of the Owner (if the estimate was prepared for another organization) or the Customer (if the estimate was prepared for another department within the same organization) (optional).
- *Project Type*: Click the small arrow and select the type of project from the drop-down list.
- *Project Sub-Type*: Click the small arrow and select the sub-type of the project from the drop-down list.
- *Project Classification*: Click the small arrow and select the classification of the project from the list.
- *Company Name*: Enter the name of the company preparing the estimate (optional).
- *Contact Person*: Enter the name of the project manager or main point-of-contact on the project (optional).
- *Contact Phone #*: Enter the phone number of the project manager or main point-of-contact on the project (optional).

In addition, two check-boxes are provided to enable the user to control special issues as follows:

- *Extenuating Circum.*: Check this box if extraordinary or extenuating circumstances occurred after the estimate was performed that could not and should not have been anticipated during the estimate process. Checking this box will eliminate the project from inclusion in any queries from the Query form. Uncheck this box if no extraordinary circumstances occurred.
- *Show ToolTips*: Check this box to enable ToolTips for the Division tabs. Uncheck this box to disable ToolTips. See *Division tabs* (below) for additional information regarding ToolTips.

The lower portion of the Project Info tab allows the user to input and edit cost information relating to a given estimate as follows (if "Actual Costs" was selected from the Estimate # box, the actual costs should be entered):

- *Engineering Design*: Enter the estimated (or actual) engineering design costs.

- *Engineered Equipment*: Enter the estimated (or actual) engineered equipment costs.
- *Bulk Materials*: Enter the estimated (or actual) bulk material costs.
- *Construction*: Enter the estimated (or actual) construction costs.
- *Other Costs (& Description)*: Enter any estimated (or actual) costs that were not included in one of the other categories. Enter the description of these costs in the box provided.
- *Owner's Costs*: Enter the estimated (or actual) Owner costs.
- *Contingency*: Enter the amount of included for the estimate (or leave blank for actual). Enter the contingency as a percentage of the base estimate in the <%> box or as a dollar amount in the <Contingency> box. ESP will then calculate the corresponding percentage or dollar amount. NOTE: If contingency is "buried" in the other cost items and not broken out separately, leave the <Contingency> box blank and ESP will exclude the estimate from queries whenever the <Base Estimate> contingency option is utilized on the Query form. If no contingency was applied and no contingency was "buried" in the other cost items, enter zero in the <Contingency> box.
- *Total Project Cost*: ESP will sum all the cost categories as they are entered and display the total in the <Total Project Cost> box.

In addition, the user can record the level of completion (in percent) of the following at the time when the estimate was performed:

- *Business Unit Study*: Enter a value between 0 and 100.
- *Preliminary Engineering*: Enter a value between 0 and 100.
- *Detailed Engineering*: Enter a value between 0 and 100.
- *Procurement*: Enter a value between 0 and 100.
- *Construction*: Enter a value between 0 and 100.

The last item on the Project Info tab allows the user to record any additional commentary that may prove useful in the future as follows:

- *Comments*: Type in any comments about the estimate or project as desired.

Division tabs

The four Division tabs provide the means for computing the Estimate Score. Each Division tab represents one of the four major determinants of estimate accuracy (*who*, *how*, *what* and *other factors*) as discussed in *Section 1: Introduction: The Estimate Score and ESP.* Each Division tab is broken down into individual elements (Figure 65 shows the Division 1 tab and the corresponding Division 1 elements). The user rates each element of each division using a 1 to 5 scale. A rating of 1 represents the "best" possible score an element can receive, whereas a 5 corresponds to the "worst" possible score. The Appendix provides an explanatory paragraph for each element as well as a "suggested rating" to assist the user in determining whether a rating of 1 or 5, or somewhere in-between, is most appropriate. The "suggested rating" first poses a question and then lists five possible answers with each answer corresponding to a rating of 1, 2, 3, 4 or 5.

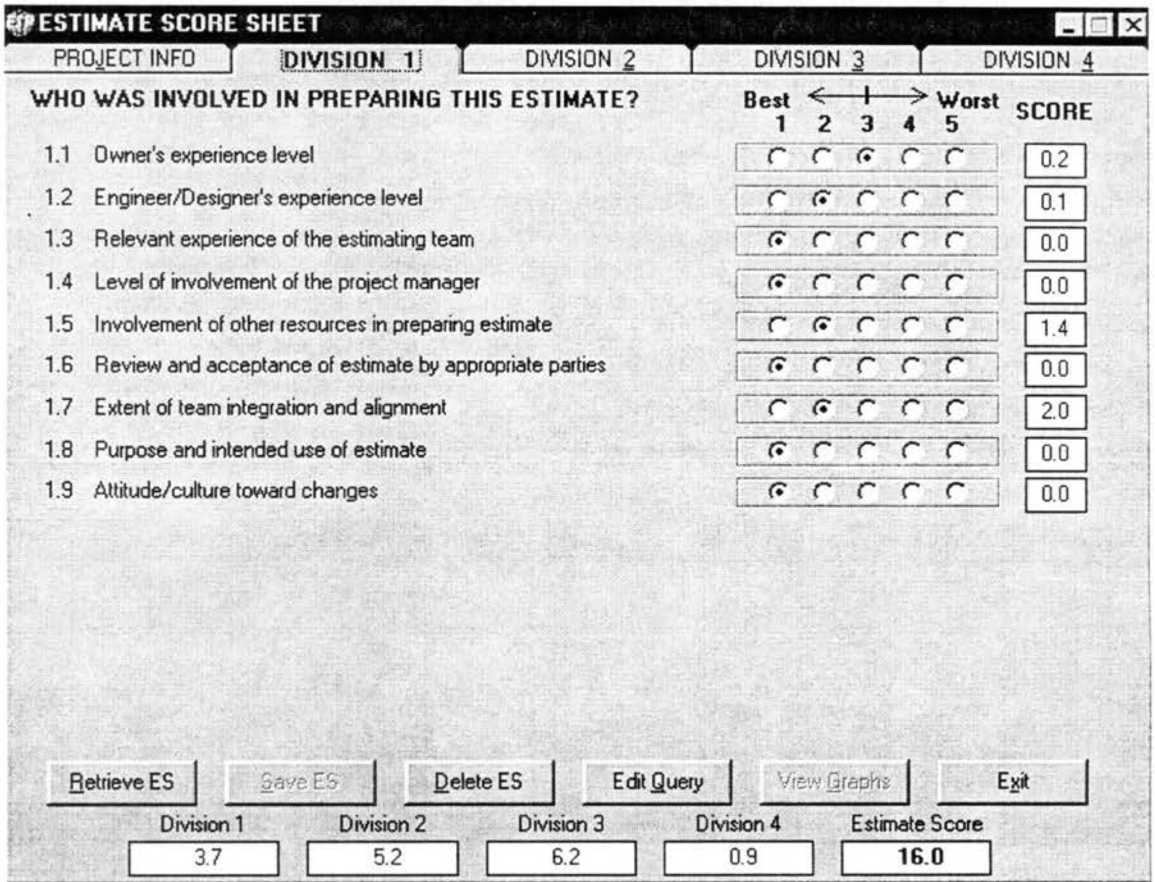


Figure 65– Estimate Score Sheet Form (Division 1 Tab)

In addition to the Appendix, the explanatory information is available to the user on-screen. The user can access the entire text of explanatory information through the context-sensitive on-line help files (accessible by pressing the F1 key at any time). However, if the user desires more succinct assistance, this is available through the use of ToolTips. ToolTips are short messages that "pop up" whenever the cursor moves over a certain area of the form. To enable the ToolTips, make sure the <Show ToolTips> check-box is checked on the Project Info tab (see Figure 64). As long as the ToolTips are enabled, the "suggested rating" question will appear whenever the cursor moves over one of the element descriptions and the "suggested rating" answer for a given rating number will appear whenever the cursor is placed over one of the rating-number option buttons.

The user can select the proper rating for a given element by clicking the option button corresponding to the desired rating for that element. Then a "score" for that element will appear in the <Score> box next to the element. This score is then added to the remaining scores for that division and the total Division Score is displayed at the bottom of the form. In addition the sum of the four Division Scores is displayed in the <Estimate Score> box. The Estimate Score is a number between zero and one hundred (with Estimate Scores closer to zero corresponding to "better" estimates and Estimate Scores closer to one hundred representing "poorer" estimates).

Query form

The Query form enables the user to query ESP's database of completed projects. After querying the database, the user can view the results of the query graphically via the Graphs form or can display various statistical information via the Statistics form. The Query form, as shown in Figure 66, contains several different buttons and boxes to assist the user in obtaining the most useful mix of completed projects from the database. These various buttons and boxes functions as follows:

- *Contingency Option*: Select the appropriate option to either exclude or include contingency in the desired query. Excluding contingency will base all overrun/underrun calculations on the "Base Estimate" only. Excluding contingency will also exclude from the analysis any estimates that do not have contingency "broken out" as a separate item in the estimate. Including contingency (selecting the <Base + Contingency> option) will calculate any overrun or underrun from the base estimate plus any contingency.
- *Any* or *All*: Select "Any" to include projects that meet *any* of the criteria listed (same as a logical OR). Select "All" to include only those projects that meet *all* of the criteria listed (same as a logical AND). The selected option only applies to the level directly below it.
- *Level*: Two levels are available for querying the database. Each level can contain up to six selection criteria. The use of both levels is not necessary unless the user desires to mix "Any" and "All" requirements. For instance, to query all "Electrical (Generating)" projects over $10,000,000 and all "Oil Refining" projects over $8,000,000, include the requirements for "Electrical (Generating)" and "greater than $10,000,000" in the upper level with the <All> option selected and include the "Oil Refining" and "greater than $8,000,000" requirements in the lower level with the <All> option selected.
- *Check-box*: Check the check-box to activate and enable the corresponding row of criteria boxes. Uncheck the check-box to deactivate and disable the corresponding row of criteria boxes.

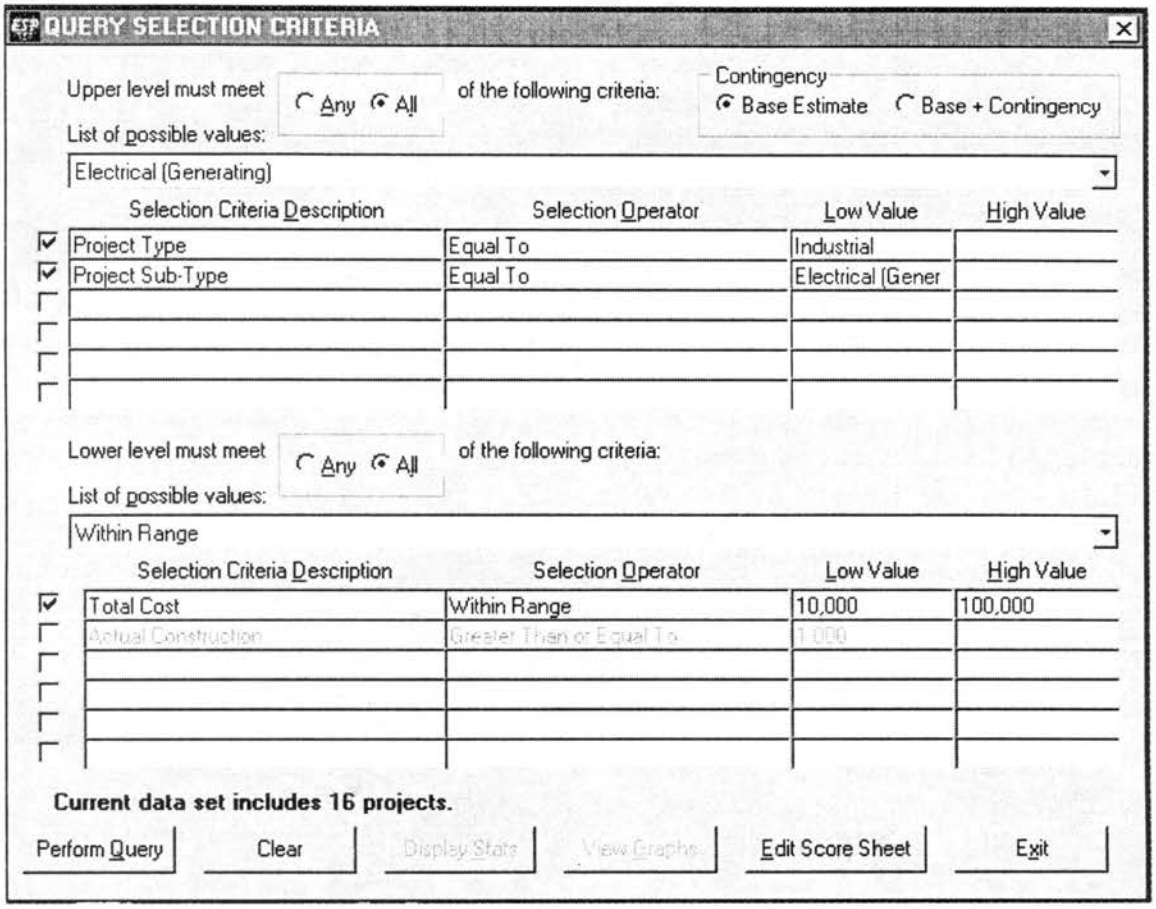


Figure 66–Query Form

- *Selection Criteria Description*: Click on the <Selection Criteria Description> box next to a checked check-box. The <List of possible values> box will display the allowable values for the Selection Criteria Description box. See *List of possible values* below.
- *List of possible values*: Click the small arrow to view a list of all the possible values for the corresponding criteria box. Select the desired value from the list.
- *Selection Operator*: Click in the Selection Operator box in the same row as a checked check-box. The <List of possible values> box will display the allowable values for the <Selection Operator> box. See *List of possible values* above.
- *Low Value*: Click in the <Low Value> box in the same row as a checked check-box. If the value in the corresponding <Selection Criteria Description> box requires a value from a limited list, the <List of possible values> box will display the allowable values for the <Low Value> box as a drop-down list. See *List of possible values* above. Otherwise, enter the "low" value (if a range is required) or the comparison value (if a range is not required) in the <Low Value> box.
- *High Value*: If the <Selection Operator> box contains a value such as "Within Range" which requires a low value and a high value, click in the <High Value> box

in the same row. If the value in the corresponding <Selection Criteria Description> box requires a value from a limited list, the <List of possible values> box will display the allowable values for the <High Value> box as a drop-down list. See *List of possible values* above. Otherwise, enter the "high" value in the <High Value> box.

Statistics form

The Statistics form, as shown in Figure 67, enables the user to view up to fifteen different pieces of statistical information about the current set of completed projects as queried from the Query form. Four drop-down list boxes are used to control the statistics to be displayed by the Statistics form. The drop-down list boxes function as follows:

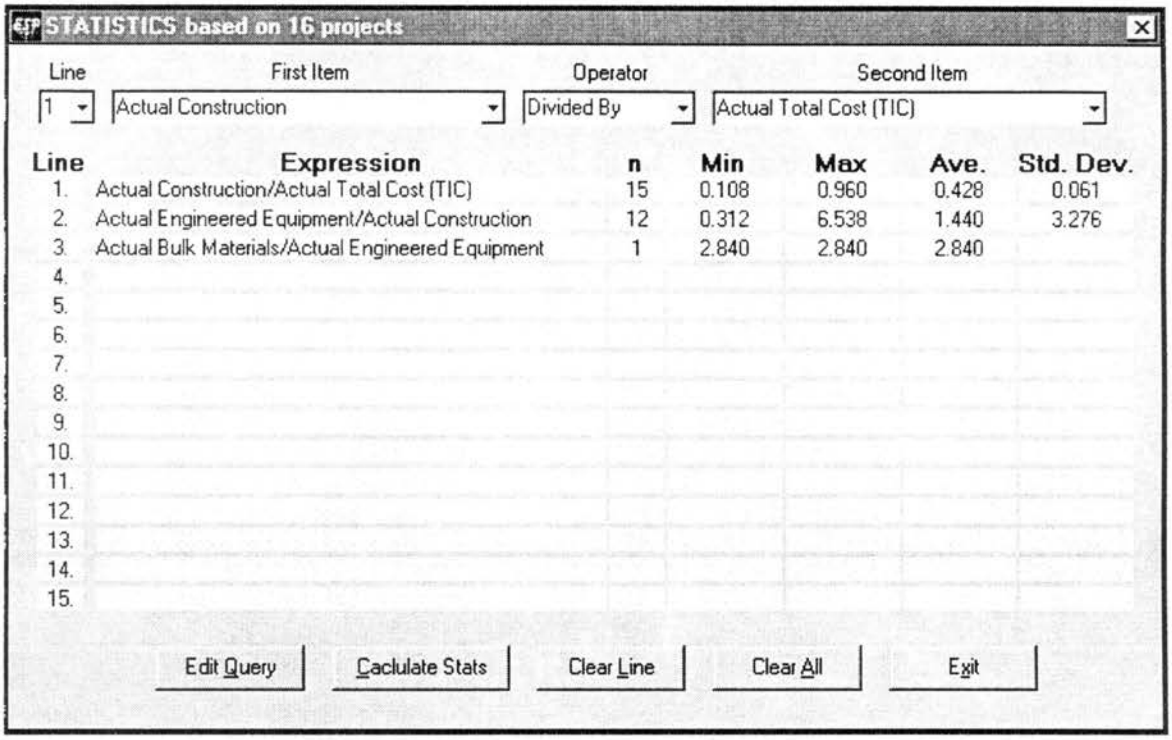


Figure 67–Statistics Form

- *Line*: Click the small arrow and select the line number of the desired display location for the specified statistical information. If the selected line is non-blank, ESP will complete the <First Item>, <Operator> and <Second Item> boxes with the corresponding information from the selected display line. Clicking on one of the display lines below will update the <Line> box to that number and fill in the other boxes appropriately.

- *First Item*: Click the small arrow and select the desired first item in the expression (i.e. the numerator in a division expression or the first item in a subtraction expression) from the drop-down list.

- *Operator*: Click the small arrow and select the desired operator to be used in the expression.

- *Second Item*: Click the small arrow and select the desired second item in the expression (i.e. the denominator in a division expression or the subtracted item in a subtraction expression) from the drop-down list.

Graphs form

The Graphs form enables the user to graphically view information about the current set of completed projects as queried from the Query form. In addition, the user can calculate prediction bands for the current data set as well as confidence limits corresponding to the Estimate Score of the current estimate (as computed from the Estimate Score Sheet form). The tabs on the Graphs form enable the user to flip back and forth between two very important graphical representations. The tabs display the following information:

Scatter Plot tab

Click the Scatter Plot tab to view (as shown in Figure 68) a scatter-plot of the current data set with prediction bands according to the selected options (see below).

S-Curve tab

Click the S-Curve tab to view (as shown in Figure 69) a cumulative probability curve based on the current data set and the value in the <Estimate Score> box (see below).

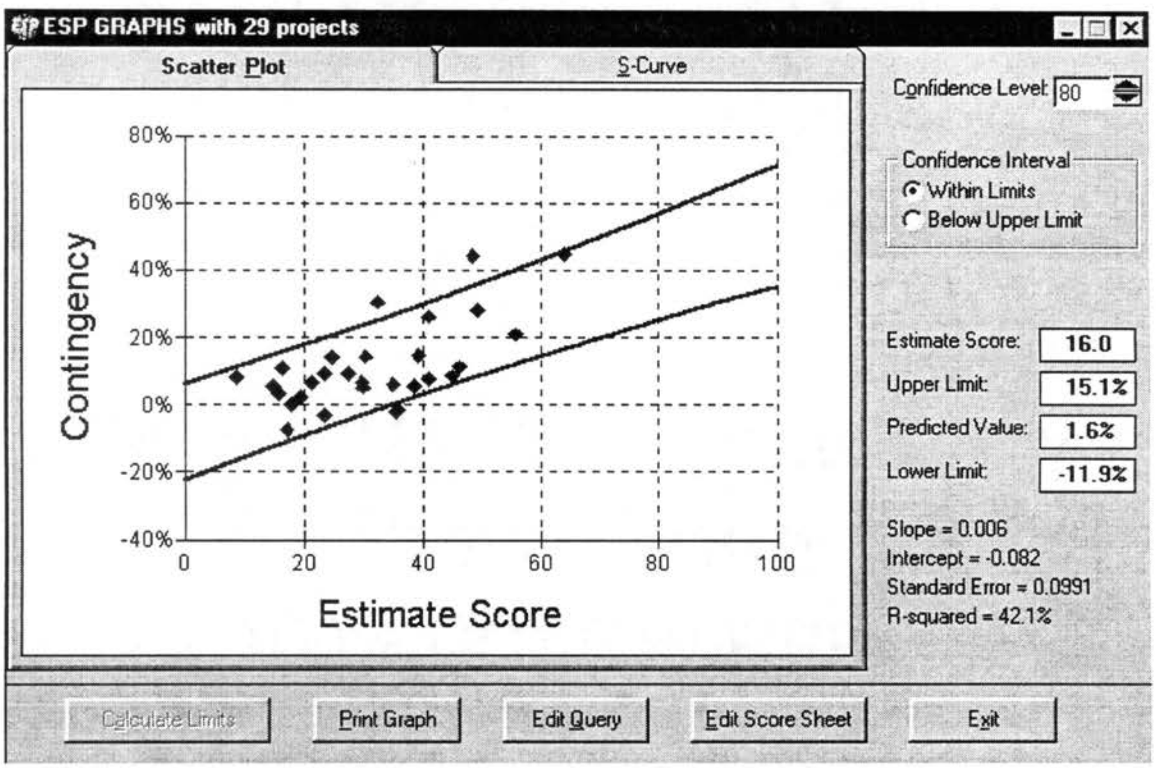


Figure 68–Graphs Form (Scatter Plot Tab)

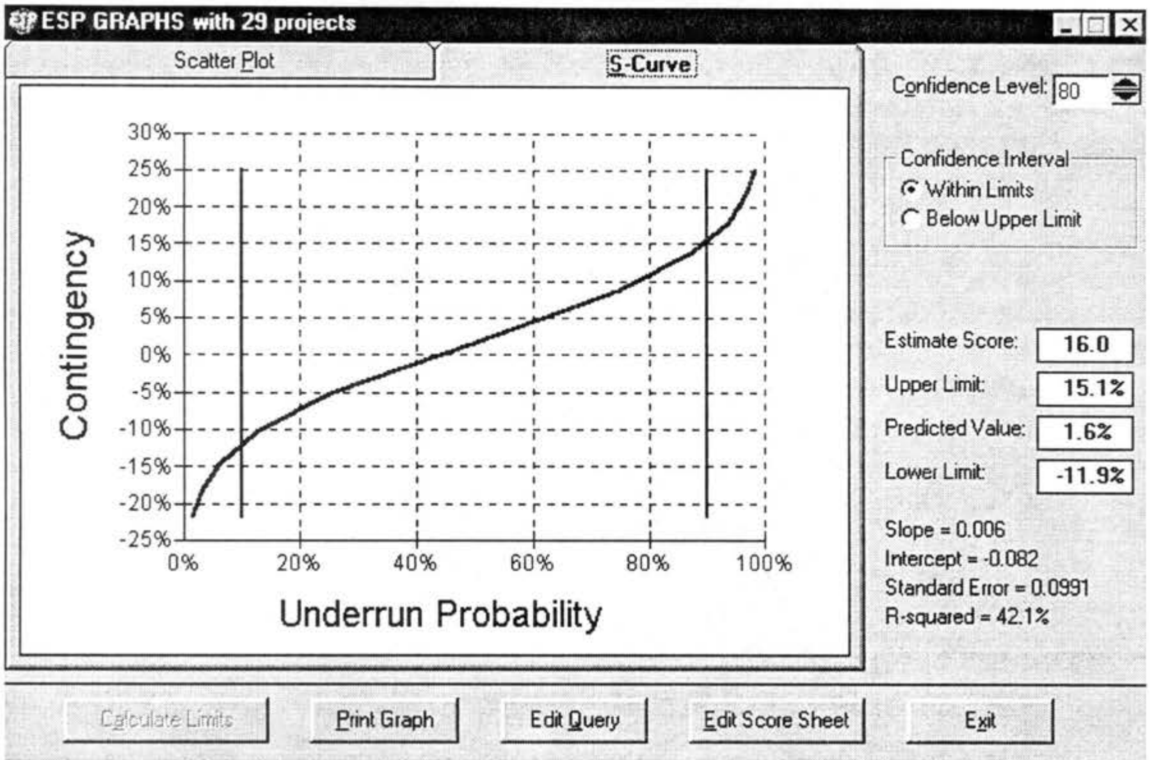


Figure 69–Graphs Form (S-Curve Tab)

In addition to the tabs, several boxes and buttons are provided on the Graphs form to assist the user in controlling the information displayed on the graphs. These function as follows:

- *Confidence Level*: Enter the desired confidence level in percent (between 0 and 100) or click the up/down arrows to increment/decrement the confidence level by fives.
- *Confidence Interval*: Select the desired type of confidence interval. For example, selecting an 80 percent confidence level with the <Within Limits> option means that, on average, eighty projects out of a hundred will fall within the calculated prediction bands, with ten out of a hundred falling above the upper limit and ten falling below the lower limit. By contrast, selecting a 90 percent confidence level with the <Below Upper Limit> option means that, on average, ninety projects out of a hundred will fall below the calculated prediction band, with ten out of a hundred falling above the upper limit. The prediction band under this scenario exactly corresponds with the upper prediction band from the former scenario. ESP updates the <Confidence Level> box to the corresponding equivalent whenever the <Confidence Interval> options are switched back and forth.
- *Estimate Score*: If an estimate has been selected using the Estimate Score Sheet form, its corresponding Estimate Score will be displayed in the Estimate Score box. If no estimate has been selected, enter an Estimate Score. ESP uses the value

displayed in the <Estimate Score> box to calculate the S-Curve (see above), the <Predicted Value>, <Upper Limit> and <Lower Limit> (see below).

- *Upper Limit*: The <Upper Limit> box displays the point-estimate of the upper confidence limit based on the Estimate Score and the selected <Confidence Level>.
- *Predicted Value*: The <Predicted Value> box displays the predicted contingency value based on a 50% probability of underrun based on the Estimate Score. The predicted value represents the y-value of the "best-fit" line for the given Estimate Score.
- *Lower Limit*: The <Lower Limit> box displays the point-estimate of the lower confidence limit based on the Estimate Score and the selected <Confidence Level>. (NOTE: Lower Limit is not applicable when the <Below Upper Limit> confidence interval option is selected).
- *Slope*: The <Slope> label displays the slope of the "best fit" line through the data.
- *Intercept*: The <Intercept> label displays the y-intercept of the "best fit" line.
- *Standard Error*: The <Standard Error> label displays the standard error of the "best fit" line.
- *R-Squared*: The <R-Squared> label displays the coefficient of determination (r-squared value) of the "best fit" line. The coefficient of determination describes the amount of variability in the data that is explained by the model (i.e. how much of the data falls "close" to the predicted "best fit" line.

Section 5: Utilizing ESP

Entering a New Estimate

To enter a new estimate into the database for an existing project:

1. Click on the <Project ID> box (on the Project Info tab of the Estimate Score Sheet form).
2. Select the project identifier from the drop-down list.
3. Press the <Tab> key. ESP will display a list of the previous estimates for the selected project in the <Estimate #> box. ESP will also display a "New Estimate" option in the <Estimate #> box.
4. Select "New Estimate" from the drop-down list to enter a new estimate into the database. ESP will ask if the new "estimate" will be ACTUAL costs.
5. Click <No> if the new estimate is truly an estimate and not a reporting of actual project costs. (Click <Cancel> if a new estimate is not desired). ESP will confirm that the new estimate has been "saved". This means that ESP has allocated space in the database for the new estimate.
6. Press the <Tab> key to go to the next field which is <Estimate Description>.
7. Type in the description of the first estimate for the new project. The estimate description could be the estimate class, or level, or some other designation that is meaningful to the user.
8. Continue completing the project and estimate fields by clicking on the individual boxes or pressing the <Tab> key to advance to the next field. See *Section 6: Navigating the Forms and Tabs of ESP* for detailed descriptions of the individual fields on the Project Info tab.
9. Score the estimate as described below.

Entering a New Project and Estimate

To enter a new estimate into the database for a new project (one that is not currently stored in the database):

1. Click on the <Project ID> box (on the Project Info tab of the Estimate Score Sheet form).
2. Type the project identifier.
3. Press the <Tab> key. ESP will ask if the new "estimate" will be ACTUAL costs.
4. Click <No> if the new estimate is truly an estimate and not a reporting of actual project costs. ESP will confirm that the new project and estimate have been "saved". This means that ESP has allocated space in the database for the new project and its initial estimate.
5. Follow Steps 1 – 9 of *Entering a New Estimate*.

Opening an Existing Estimate

To open an existing estimate:

1. Click on the <Project ID> box (on the Project Info tab of the Estimate Score Sheet form).
2. Select the project identifier from the drop-down list.

3. Press the <Tab> key. ESP will display a list of the previous estimates for the selected project in the <Estimate #> box.
4. Select the desired estimate from the drop-down list. NOTE: ESP tracks estimates for a given project according to the sequential order in which they were entered.
5. Click the <Retrieve ES> command button to retrieve the estimate and its Estimate Score from the database.

Scoring an Estimate

To score an estimate:

1. Open an existing estimate or enter a new estimate as described above.
2. Click the <Division 1> tab.
3. Rate each element from 1 to 5 (with a "1" being "best" and a "5" being "worst"). The Appendix and the on-line help provide a detailed description and suggested rating for each element. The suggested ratings are also available via on-screen ToolTips. See *Section 6: Navigating the Forms and Tabs of ESP* for instructions regarding ToolTips.
4. Repeat Steps 2 – 3 for each of the four divisions. See *Section 1: Introduction: The Estimate Score and ESP* and *Section 2: Why Use ESP?* (above) as well as *Evaluating an Estimate* (below) for information regarding the background and use of the Estimate Score.

Querying the Completed Projects Database

To query the completed projects database:

1. Go to the Query form by clicking the <Edit Query> command button from any of the other forms in ESP. See *Section 6: Navigating the Forms and Tabs of ESP* for instructions regarding locating forms in ESP.
2. Click one of the six check-boxes on the upper left-hand side of the form. ESP will place a checkmark in the box.
3. Click the <Selection Criteria Description> box adjacent to the checked box.
4. Click the <List of possible values> box.
5. Select the desired selection criterion from the drop-down list.
6. Click the <Selection Operator> box adjacent to the checked box.
7. Click the <List of possible values> box.
8. Select the desired operator from the drop-down list.
9. Click the <Low Value> box adjacent to the checked box.
10. If the desired selection criterion requires values from a limited list, click the <List of possible values> box and select the desired "low" value from the drop-down list. The "low" value represents the value to be applied to the selection criterion and its operator or the lower bound for a "Within Range" or "Not Within Range" operator.
11. If the desired selection criterion does not require values from a limited list, type the desired "low" value in the appropriate <Low Value> box.
12. If the desired selection operator requires a range, repeat Steps 9 – 11 for the corresponding <High Value> box.

13. Repeat Steps 2 – 12 until all desired selection criteria have been identified.
14. Click the upper <Any> option if a logical OR is desired for the "checked" selection criteria. (In other words, *any* records in the database that meet at least one of the selection criteria will be returned from the query).
15. Click the upper <All> option if a logical AND is desired for the "checked" selection criteria. (In other words, only those records in the database that meet *all* of the selection criteria will be returned from the query).
16. Repeat Steps 2 – 15 for the six check-boxes on lower left-hand side of the form if a combination of logical AND's and OR's is required. For instance, to query the database for all "Electrical (Generating)" projects over $10,000,000 and all "Oil Refining" projects over $8,000,000, utilize the upper level for the first two criteria (with the upper <All> option selected) and utilize the lower level for the last two criteria (with the lower <All> option selected). The query will then select those projects that satisfy *all* of the upper two criteria *or all* of the lower two criteria.
17. If contingency evaluations are going to be made based on the resulting query, click the <Base Estimate> contingency option.
18. If historical underrun/overrun evaluations are going to be made based on the resulting query, click the <Base + Contingency> option. Selecting this option will disable all but the "Scatter Plot" on the Graphs form.
19. Click the <Perform Query> command button to query the database based on the "checked" selection criteria. NOTE: Clicking one of the "checked" check-boxes will "uncheck" the box and remove the corresponding selection criterion from the query.

Viewing Statistics from the Completed Projects Database

To view statistics about the projects in the "Completed Projects" database:

1. Perform a query of the "Completed Projects" database as detailed in *Querying the Completed Projects Database* above.
2. Click the <Display Stats> command button to open the Statistics form.
3. Click on the <Line> box in the upper left-hand corner of the Statistics form.
4. Select a line to designate the location for the desired statistics. NOTE: Clicking on one of the line numbers on the left-hand side of the form or on one of the lines itself will activate that line number in the <Line> box and place the current values from the <First Item>, <Operator> and <Second Item> boxes in the <Expression> portion of the selected line.
5. Click on the <First Item> box.
6. Select the desired "first item" from the drop-down list. The "first item" will be the first item in the expression (i.e. the numerator for a division operation).
7. Click on the <Operator> box.
8. Select the desired operator from the drop-down list.
9. Click on the <Second Item> box.
10. Select the desired "second item" from the drop-down list. The "second item" will be the second item in the expression (i.e. the denominator for a division operation or the subtracted item in a subtraction expression).

11. Press the <Tab> key.
12. Repeat Steps 3 – 11 as desired for additional statistical information.
13. Click the <Calculate Stats> command button to calculate and display the desired statistics.
14. Click the <Edit Query> command button to go back to the Query form to change the query selection criteria or to utilize the other functions of ESP.

Evaluating an Estimate

To determine the amount of contingency to add to an estimate based on its Estimate Score and historical projects from the "Completed Projects" database:

1. Open an existing estimate or enter a new estimate as described in *Opening an Existing Estimate* and *Entering a New Estimate* above.
2. Score the estimate as described in *Scoring an Estimate* above.
3. Perform a query of the "Completed Projects" database as detailed in *Querying the Completed Projects Database* above. NOTE: Make sure the <Base Estimate> contingency option is selected.
4. Click the <View Graphs> command button on the Query form or the Estimate Score Sheet form.
5. If an upper limit only is desired, select the <Below Upper Limit> confidence interval option on the upper right-hand side of the form.
6. If a confidence range is desired, select the <Within Limits> confidence interval option. NOTE: The confidence level will be the upper limit probability minus the lower limit probability. For instance, an 80% confidence level will go from an upper limit of 90% to a lower limit of 10% (90 – 10 = 80). Thus, the upper bound for a 80% "within limits" confidence interval is the same as the upper bound for an 90% "below upper limit" confidence interval.
7. Select the desired confidence level (between zero and 100) by entering the desired value in the <Confidence Level> box or clicking the up/down arrows adjacent to the <Confidence Level> box. The up/down arrows will increment/decrement the confidence level by fives.
8. Click the <Calculate Limits> command button to calculate and display the prediction bands and upper and lower limits.
9. Click the <Scatter Plot> tab to view the "Scatter Plot". ESP displays the "Scatter Plot" of all the projects returned from the query along with the calculated prediction bands based on those projects.
10. Click the <S-Curve> tab to view the "S-Curve". ESP calculates the "S-Curve" based on the projects from the query and the Estimate Score for the current estimate. The "S-Curve" represents the cumulative probability of underrun for a given Estimate Score. The contingency value on the y-axis represents the amount of contingency (as a percentage) that must be *added to the base estimate* to achieve the corresponding probability of underrun. NOTE: If no estimate has been retrieved via the Estimate Score Sheet form, a value may be entered in the <Estimate Score> box and the S-Curve that applies to the entered Estimate Score can be calculated.

11. Determine the amount of contingency to applied to the base estimate based on the desired confidence level.
12. Click the <Estimate Score Sheet> button to return to the Estimate Score Sheet form.
13. Click the <Project Info> tab on the Estimate Score Sheet form.
14. Click on the <%> box.
15. Type the desired contingency (as a percentage).
16. Press the <Tab> key.

Performing Sensitivity-Analysis of Estimate Score on Recommended Contingency

To analyze the impact of changes to the Estimate Score on the amount of recommended contingency:

1. If an estimate is currently "open", select a new project from the <Project ID> box on the Project Info tab of the Estimate Score Sheet form and press the <Tab> key.
2. Perform a query of the "Completed Projects" database as detailed in *Querying the Completed Projects Database* above. NOTE: Make sure the <Base Estimate> contingency option is selected.
3. Click the <View Graphs> command button on the Query form or the Estimate Score Sheet form.
4. Click on the <Estimate Score> box on the Graphs form.
5. Type an Estimate Score (between zero and one hundred) in the <Estimate Score> box.
6. Performs Steps 5 – 10 from *Evaluating an Estimate* above.
7. Repeat Steps 4 – 6 above with additional Estimate Score values as desired.

Entering Actual Costs (Adding a Project to the Completed Projects Database)

To add a project to the "Completed Projects" database:

1. Click on the <Project ID> box (on the Project Info tab of the Estimate Score Sheet form).
2. Select the project identifier from the drop-down list.
3. Press the <Tab> key. ESP will display a list of the previous estimates for the selected project in the <Estimate #> box. ESP will also display a "New Estimate" option in the <Estimate #> box.
4. Select "New Estimate" from the drop-down list to enter new cost data into the database. ESP will ask if the new "estimate" will be ACTUAL costs.
5. Click <Yes> if the new "estimate" is truly a reporting of actual project costs. ESP will confirm that the new "estimate" has been "saved". This means that ESP has allocated space in the database for the actual cost data.
6. Enter the actual cost data in the appropriate fields. NOTE: ESP records "100" for each of the "%-Complete" boxes for each project phase. In addition, ESP records "N/A" meaning "Not Applicable" in the <Contingency> box.

Evaluating Actual Cost-Performance of Completed Projects

To evaluate the levels of underrun/overrun (after adding contingency) for projects in the "Completed Projects" database:

1. Perform a query of the "Completed Projects" database as detailed above. NOTE: Make sure the <Base + Contingency> option is selected.
2. Click the <View Graphs> command button on the Query form or the Estimate Score Sheet form. ESP will display the "Scatter Plot" of all the projects returned from the query. NOTE: The "S-Curve" and confidence level options on the Graphs form are disabled whenever the <Base + Contingency> option is selected on the Query form.

Using Hot-Keys and the <Tab> Key

Each of the forms of ESP provides hot-keys to enable the user to quickly navigate the form. Hot-keys are identified by the underscore character "_". An option, box or command button can be accessed by pressing the <Alternate> key along with the keyboard character corresponding to the underscored character of the desired item. Whenever multiple items on a single form use the same hot-key, pressing the <Alternate> key plus the hot-key multiple times will toggle between the various items.

In addition to hot-keys, the <Tab> key can be utilized to navigate between items on an individual form. Pressing the <Tab> key will move the cursor to the next option, box or command on the form.

Section 6: Executing the Commands of ESP

Figure 70 gives a graphical representation of the commands that are available from each of the forms of ESP. The commands function as follows:

Estimate Score Sheet form

- *Retrieve ES*: Retrieves an estimate and its estimate score from the database based on the information in the <Project ID> and <Estimate #> boxes.
- *Save ES*: Saves the estimate and estimate score information to the database based on the information in the <Project ID> and <Estimate #> boxes. NOTE: The <Save ES> command is not available if no changes have been made since the project and estimate were last saved.
- *Delete ES*: Deletes an estimate and its estimate score from the database based on the information in the <Project ID> and <Estimate #> boxes. (NOTE: Deleting an estimate from the database is permanent and cannot be undone!).
- *Edit Query*: Hides the Estimate Score Sheet form and displays the Query form.
- *View Graphs*: Hides the Estimate Score Sheet form and displays the Graphs form. NOTE: The <View Graphs> command is not available if no query of the completed projects database has been performed.
- *Exit*: Exits the program.

Query form

- *Perform Query*: Queries the database based on the chosen selection criteria. NOTE: The <Perform Query> command is not available if a query has already been performed and no changes have been made to the selection criteria or the query options.
- *Clear*: Clears the upper and lower selection criteria levels of the Query form.
- *Display Stats*: Hides the Query form and displays the Statistics form. NOTE: The <Display Stats> command is not available if no query of the completed projects database has been performed.
- *View Graphs*: Hides the Query form and displays the Graphs form. NOTE: The <View Graphs> command is not available if no query of the completed projects database has been performed.
- *Edit Score Sheet*: Hides the Query form and displays the Estimate Score Sheet form.
- *Exit*: Exits the program.

Statistics form

- *Edit Query*: Hides the Statistics form and returns to the Query form.
- *Calculate Stats*: Calculates the desired statistics from the expressions shown on each display line. (The statistics are based on the current data set according to the query performed from the Query form). NOTE: The <Calculate Stats> command is

not available if statistics have already been calculated and no changes have been made.

- *Clear Line*: Clears all information from the current display line.
- *Clear All*: Clears all information from all display lines.
- *Exit*: Exits the program.

Graphs form

- *Calculate Limits*: Calculates the prediction bands, point-estimates and S-Curve based on the Confidence Level, Confidence Interval and Estimate Score values and then updates the Scatter Plot and S-Curve graphs as well as the <Upper Limit> and <Lower Limit> boxes and the <Slope>, <Intercept>, <Standard Error> and <R-Squared> labels.
- *Print Graph*: Prints the current graph.
- *Edit Query*: Hides the Graphs form and displays the Query form.
- *Edit Score Sheet*: Hides the Graphs form and displays the Estimate Score Sheet form.
- *Exit*: Exits the program.

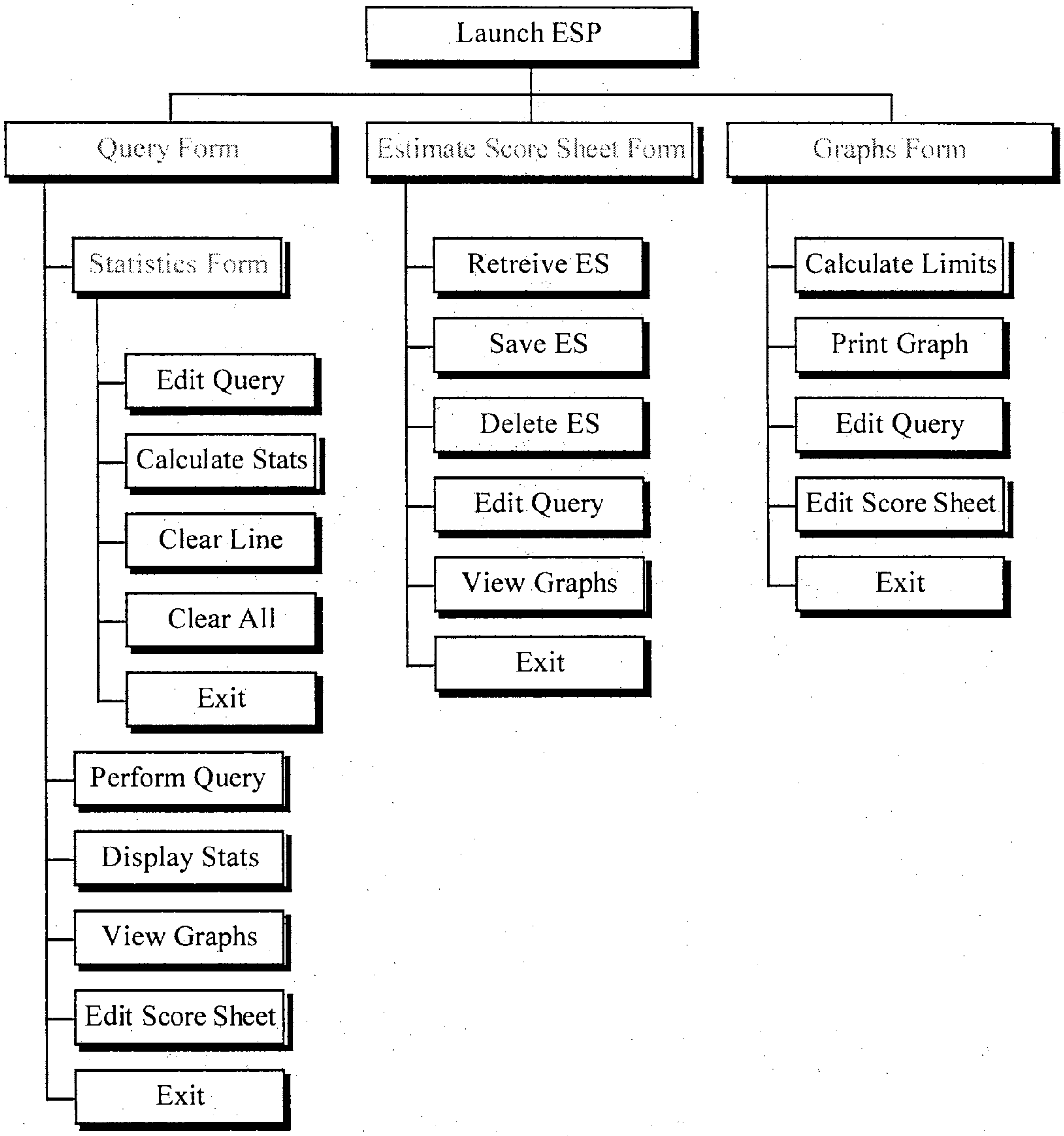


Figure 70–Breakdown of ESP Commands

Section 7: Customizing ESP

ESP was developed to provide as much functionality and flexibility to the user as practicable. To accomplish this, the developers emphasized the use of the database to store functional information rather than "hard-coding" items into the software's source code. Utilizing the database as a storage location for functional information gives the user great amounts of flexibility in the utilization of ESP. However, caution must be exercised whenever the database is manipulated. The user, by altering the database, can cause breakdowns in the functionality of the software. For instance, changing field names or field requirements can cause the software to improperly communicate with the database and thus cause the software to function improperly or not at all. ***Prior to altering the database, the user should create an archive copy of the current database to guard against accidental corruption.*** The following items outline the areas where the user can modify the database to better meet the needs of his or her specific organization:

Changing Division Titles

To change the titles of the Estimate Score divisions:

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the "Division" table.
3. Edit the *Division_Description* field for the desired division(s): NOTE: Division titles requiring an "&" must be typed as "&&". Changing division titles in the database file will NOT change the titles displayed in the on-screen help.

Changing Element Titles

To change the titles of individual elements:

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the "Weight" table.
3. Edit the *Element_Description* field for the desired element(s): NOTE: Element titles requiring an "&" must be typed as "&&". Changing element titles in the database file will NOT change the titles displayed in the on-screen help.

Changing Element Weights

To alter the weights of individual elements:

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the "Weight" table.
3. Edit the following fields for the desired element(s): *0_Weight*, *1_Weight*, etc.

Changing Element ToolTips

To alter the ToolTips of individual elements:

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the "Weight" table.
3. Edit the following fields for the desired element(s): *Help_Question*, *1_Help*, *2_Help*, etc. NOTE: ToolTips requiring an "&" must be typed as "&&". Changing element ToolTips in the database file will NOT change the suggested ratings displayed in the on-screen help.

Creating Additional Elements

To create additional elements:

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the "Weight" table.
3. Add one record for each additional element (up to a total of fourteen elements per division). For the *Element_Number* field, use the following format: ES_#_## where # = division number and ## = element number. NOTE: Element descriptions requiring an "&" must be typed as "&&". Additional elements will NOT be displayed in the on-screen help.

Editing Project Data Directly in the Database

To edit project information directly in the database:

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the "Project" table.
3. Edit the desired field(s) for the desired project(s).

Editing Estimate Data Directly in the Database

To edit estimate data directly in the database:

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the "Project" table.
3. Make note of the *Project_ID* field for the desired project(s).
4. Open the "Estimate" table.
5. Locate the desired project(s) using the *Project_ID* value(s) obtained in Step 3.
6. Edit the desired field(s) for the desired project(s).

Editing Actual Cost Data Directly in the Database

To edit actual cost data directly in the database:

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the "Project" table.
3. Make note of the *Project_ID* field for the desired project(s).
4. Open the "Completed_Project" table.
5. Locate the desired project(s) using the *Project_ID* value(s) obtained in Step 3.
6. Edit the desired field(s) for the desired project(s).

Creating Additional Query Selection Criteria

To create additional fields in the database (i.e. to accommodate additional querying capabilities):

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the following table(s) using the "Table Design" view: "Project", "Estimate", "Completed_Project".
3. Create additional field(s) as desired for each table.
4. Change to the "Datasheet" view for each table.
5. Input the appropriate project/estimate data for each new field.

6. Open the "Selection" table.
7. Create a new record for each new field. The record should contain the following information in the appropriate fields:

Filter field:	Enter a description of the new selection criterion. The description will appear in the drop-down list on the Query form.
Filter_Use field:	Enter the name of the new field according to the following format: *TableName.FieldName*.
Field_Type field:	Enter the type of the new field (i.e. "Date/Time", "Text", "Number", etc.).

Creating Additional Fields for Historical Statistics

To create additional fields in the database (i.e. to accommodate additional statistical reporting of completed projects):

1. Complete Steps 1 – 5 of *Creating Additional Query Selection Criteria.*
2. Open the "StatsField" table.
3. Create a new record for each new field. The record should contain the following information in the appropriate fields:

Field field:	Enter a description of the new statistics field. The description will appear in the <First Item> and <Second Item> drop-down lists on the Statistics form.
Field_Use field:	Enter the name of the new field as it appears in the database. Do NOT include the table name. Include only the field name.

Creating Additional Project Types

To create additional project sub-types:

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the "Project_Type" table using the "Table Design" view.
3. Edit the validation expression for the *Project_Type* field to allow each new project type. For instance, to add a new project type named "Special", the following should be added to the existing validation rule: OR "Special"
4. Change to the "Datasheet" view for the "Project_Type" table.
5. Create a new record for each new project type. The record should contain the following information in the appropriate fields:

Project_Type field:	Enter the new project type. The new project type will now appear in the <List of possible values> drop-down list for the <Low Value> and <High Value> boxes on the Query form.
Project_Sub_Type field:	Enter a suitable project sub-type for the new project type. The new project sub-type will now appear in the <List of possible values> drop-down list for the <Low Value> and <High Value> boxes on the Query form.

6. Open the "Project" table using the "Table Design" view.
7. Edit the validation expression for the *Project_Type* field to allow each new project type. For instance, to add a new project type named "Special", the following should be added to the existing validation rule: OR "Special"
8. Open the "ProjectCombo" table using the "Table Design" view.
9. Create a new field using the new project type as the field name. The field name should be designated as type "Text".
10. Change to the "Datasheet" view for the "ProjectCombo" table.
11. Type the new project type into the *Project_Type* field of one of the records with an empty *Project_Type* field.
12. Type the new project sub-type into the new field created in Step 9. NOTE: The project sub-type must be typed exactly as that which was used for Step 5. The new project type will now appear in the <Project Type> drop-down list and the new project sub-type will now appear in the <Project Sub-Type> drop-down list on the Project Info tab of the Estimate Score Sheet form.

Creating Additional Project Sub-Types

To create additional project sub-types:

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the "Project_Type" table.
3. Create a new record for each new project sub-type. The record should contain the following information in the appropriate fields:

Project_Type field:	Enter the project type.
Project_Sub_Type field:	Enter the new project sub-type. The new project sub-type will now appear in the <List of possible values> drop-down list for the <Low Value> and <High Value> boxes on the Query form.

4. Open the "ProjectCombo" table.
5. Type the new project sub-type into the field having the same name as the project type. NOTE: The project sub-type must be typed exactly as that which was used for Step 3. The new project sub-type will now appear in the <Project Sub-Type> drop-down list on the Project Info tab of the Estimate Score Sheet form.

Creating Additional Project Classifications

To create additional project classification:

1. Open the Microsoft Access database file "ESP.MDB".
2. Open the "ProjectCombo" table.
3. Type the new project classification into the *Project_Disposition* field. The new project classification will now appear in the <Project Classification> drop-down list on the Project Info tab of the Estimate Score Sheet form. The new project classification will appear in the <List of possible values> drop-down list for the <Low Value> and <High Value> boxes on the Query form after a project has been saved to the database using the new project classification.

APPENDIX G

ESP CODE

```
Option Explicit

Dim inActiveIndex As Integer     'Which selection criterion line is active
Dim inAnyAll As Integer          '  0 if Any      1 if All
Dim rsOperator As Recordset      'RecordSet for operator conversion from database
Dim rsSelection As Recordset     'RecordSet for selection conversion from database

'Not currently used
Dim stFilterInfo(4, 32) As String
    '0-5    chkSelect.Value
    '6-29  txtSelection.Text
    '30     optAny.Value
    '31     optAll.Value



Private Sub cboSelect_Click(Index As Integer)
    'Fill in selected box with value selected from combo box list
    txtSelection(inActiveIndex).Text = cboSelect(Index).Text
End Sub




Private Sub chkSelect_Click(Index As Integer)
    'If box is being unchecked, disable adjacent selection boxes
    If chkSelect(Index).Value = 0 Then
        txtSelection(Index).Enabled = False
        txtSelection(Index + 12).Enabled = False
        txtSelection(Index + 24).Enabled = False
        txtSelection(Index + 36).Enabled = False
    'If box is being checked, enable adjacent selection boxes
    Else
        txtSelection(Index).Enabled = True
        txtSelection(Index + 12).Enabled = True
        txtSelection(Index + 24).Enabled = True
        txtSelection(Index + 36).Enabled = True
        txtSelection(Index + 24).Locked = False
        txtSelection(Index + 36).Locked = True
    End If
    'Enable/disable the command buttons to signify that query results & query criteri
a are not the same
    cmdDoFilter.Enabled = True
    frmScoreSheet.cmdGraph.Enabled = False
    cmdGraph.Enabled = False
    cmdStats.Enabled = False
End Sub

Private Sub cmdClear_Click()
ClearQueryForm
'Enable the command button to signify that query results & query criteria are not the
 same
cmdDoFilter.Enabled = True
End Sub

Private Sub cmdExit_Click()
Call frmScoreSheet.cmdExit_Click

End Sub

Private Sub cmdDoFilter_Click()

Dim stSQL, stSubSQL As String   'SQL text strings
Dim stESLabel As String         'Element # as ES_d_ee (d=div, e=element)
```

```
Dim inCount, inCountJ, inCountK As Integer  'Counters
Dim inLevelCount As Integer     'Counter for # of active levels
Dim inNumLevels As Integer      '# of levels active (1 or 2)
Dim inNumCriteria(2) As Integer '# of selection criteria for each level
Dim sgESPossible As Single      'Total of "5" weights of all elements
Dim inElement, inElementRating As Integer   'Element # and it's rating (0 - 5) for cu
rrent estimate
Dim stCostExpr, stContingency As String     'Cost and contingency expressions for SQL
 query
Dim inDebugPrint As Integer

inDebugPrint = 0
If inDebugPrint = 1 Then
    Open "d:\cii\es.txt" For Output As #1
End If


'If <Base + Contingency> option selected, calculate cost overrun
    'and include all completed non-extenuating projects
If optContingency.Value = True Then
    stCostExpr = "(([Actual_Total]) / ([Estimated_Total]) - 1)"
    stContingency = "((Estimate.Contingency >= 0) OR (Estimate.Contingency IS NULL))"
'If <Base Estimate> option selected, calculate contingency that would have been requi
red
    'and include all completed non-extenuating projects which have contingency values
 identified
Else
    stCostExpr = "(([Actual_Total]) / (([Estimated_Total])-([Contingency])) - 1)"
    stContingency = "((Estimate.Contingency >= 0))"
End If

frmGraphs.cmdCalculate.Enabled = True

Set dbES = Workspaces(0).OpenDatabase(stDBName)

stSQL = "SELECT * FROM Operator "
Set rsOperator = dbES.OpenRecordset(stSQL, dbOpenDynaset)

stSQL = "SELECT * FROM Selection "
Set rsSelection = dbES.OpenRecordset(stSQL, dbOpenDynaset)

'Build SQL to query the database according to selected criteria
stSQL = "SELECT DISTINCTROW Completed_Project.*, Estimate.*, Project.*, " & _
    stCostExpr          '([Actual_Total])/([Estimated_Total])-1
stSQL = stSQL & " AS Expr1, (([Actual_Total]) / ([Estimated_Total]) - 1) AS Expr2 " &
 _
    " FROM (Project INNER JOIN Estimate ON Project.Project_ID = Estimate.Project_ID)
" & _
    " INNER JOIN Completed_Project ON Project.Project_ID = Completed_Project.Project_
ID " & _
    " WHERE (((Completed_Project=Yes) AND (Actual_Total>0) AND (Extenuating=0) " & _
    " AND (Estimated_Total>0) "           ');"   deleted from database query
    'add extra left parenthesis after WHERE after adding selection criteria info
    stSQL = stSQL & "AND " & stContingency & " ) "

'Build array with upper level selection criteria
For inCount = 0 To 5
    If txtSelection(inCount) = "" Or txtSelection(inCount + 12) = "" Or txtSelection(
inCount + 24) = "" Then
        chkSelect(inCount).Value = 0
    ElseIf InStr(txtSelection(inCount + 12).Text, "Range") > 0 And txtSelection(inCou
nt + 36) = "" Then
        chkSelect(inCount).Value = 0
    End If
```

```
    If chkSelect(inCount).Value = 1 Then
        inNumCriteria(0) = inNumCriteria(0) + 1
    End If
Next inCount

'Build array with lower level selection criteria
For inCount = 6 To 11
    If txtSelection(inCount) = "" Or txtSelection(inCount + 12) = "" Or txtSelection(
inCount + 24) = "" Then
        chkSelect(inCount).Value = 0
    ElseIf InStr(txtSelection(inCount + 12).Text, "Range") > 0 And txtSelection(inCou
nt + 36) = "" Then
        chkSelect(inCount).Value = 0
    End If
    If chkSelect(inCount).Value = 1 Then
        inNumCriteria(1) = inNumCriteria(1) + 1
    End If
Next inCount

'Count the number of active levels
For inCount = 0 To 1
    If inNumCriteria(inCount) > 0 Then
        inNumLevels = inNumLevels + 1
    End If
Next inCount

'Build the rest of the SQL with the selection criteria info
If inNumLevels > 0 Then
    stSQL = stSQL & " AND ("
    inLevelCount = 0
    For inCount = 0 To 1
        If inNumCriteria(inCount) > 0 Then
            inLevelCount = inLevelCount + 1
            stSQL = stSQL & BuildFilterLevel(inCount, inNumCriteria(inCount))
            If inLevelCount < inNumLevels Then
                stSQL = stSQL & " OR "
            End If
        End If
    Next inCount
    stSQL = stSQL & ")"
End If
stSQL = stSQL & ");"     'add the extra parenthesis as required


Text1.Text = stSQL       'Debugging tool

'Perform the query
Set qdFilter = dbES.OpenQueryDef("FilterQuery")
qdFilter.SQL = stSQL
Set rsFilter = qdFilter.OpenRecordset()

'Count the number of projects in the query results
If rsFilter.RecordCount > 0 Then rsFilter.MoveLast
inNumProjects = rsFilter.RecordCount
lblNumProjects.Caption = "Current data set includes " & CStr(inNumProjects) & " proje
cts."
frmGraphs.Caption = "ESP GRAPHS with " & CStr(inNumProjects) & " projects"
frmStats.Caption = "ESP STATISTICS with " & CStr(inNumProjects) & " projects"
frmFilter.Caption = "ESP QUERY with " & CStr(inNumProjects) & " projects"

'Calculate the Estimate Score and % Cost Overrun (or % Contingency) for each project
If rsFilter.RecordCount > 0 Then rsFilter.MoveFirst
For inCount = 0 To inNumProjects - 1
    sgEScore(inCount) = 0
```

```
    sgESPossible = 0
    'Loop through each division
    For inCountJ = 1 To 4
        For inCountK = 1 To inDivCount(inCountJ)
            stESLabel = "ES_" & CStr(inCountJ) & "_" & CStr(inCountK)
            inElementRating = rsFilter(stESLabel)
            inElement = 1000 * inCountJ + 10 * inCountK + inElementRating
            If inElementRating > 0 Then
                sgEScore(inCount) = sgEScore(inCount) + Val(frmScoreSheet.optERI(inEl
ement).Tag)
                inElement = 1000 * inCountJ + 10 * inCountK + 5
                sgESPossible = sgESPossible + Val(frmScoreSheet.optERI(inElement).Tag
)
            End If
        Next inCountK
    Next inCountJ
    'Calculate the ES as the ratio of raw score to "worst" possible score all 5's exc
ept N/A's
    If sgESPossible <> 0 Then
        sgEScore(inCount) = sgEScore(inCount)         ' / sgESPossible
    Else
        sgEScore(inCount) = 0
    End If
    sgCostOverrun(inCount) = rsFilter!Expr1
    If inDebugPrint = 1 Then
        Print #1, sgEScore(inCount); Tab; sgCostOverrun(inCount)
    End If
    rsFilter.MoveNext
Next inCount

If inDebugPrint = 1 Then
    Close #1
End If


'Enable/disable command buttons to signify that query results now match selection cri
teria
cmdDoFilter.Enabled = False
cmdGraph.Enabled = True
frmScoreSheet.cmdGraph.Enabled = True
frmGraphs.cmdCalculate.Enabled = True
cmdStats.Enabled = True

If inNumProjects < 10 Then
    stMSG = "Contingency predictions are not recommended with" _
        & Chr(13) & Chr(10) & "fewer than ten (10) observed data points."
    inButtons = vbOKOnly + vbInformation + vbApplicationModal
    inResponse = MsgBox(stMSG, inButtons, "Too Few Data Points")
End If


End Sub


Private Sub cmdGraph_Click()
    frmFilter.Hide
    frmGraphs.Show
End Sub


'Currently not used
Private Sub StoreFilter(inLevel As Integer)
'Dim inCount As Integer
```

```
'Dim inArrayCount As Integer

'inArrayCount = 0
'inLevel = inLevel - 1
'For inCount = 0 To 5
'    stFilterInfo(inLevel, inArrayCount) = chkSelect(inCount).Value
'    inArrayCount = inArrayCount + 1
'Next inCount

'For inCount = 0 To 23
'    stFilterInfo(inLevel, inArrayCount) = txtSelection(inCount).Text
'    inArrayCount = inArrayCount + 1
'Next inCount

'stFilterInfo(inLevel, inArrayCount) = optAny(0).Value
'inArrayCount = inArrayCount + 1
'stFilterInfo(inLevel, inArrayCount) = optAll(0).Value

End Sub


'Currently not used
Private Sub RetrieveFilter(inLevel As Integer)
'Dim inCount, inCountJ As Integer
'Dim inArrayCount As Integer

'lblOther.Caption = ""
'inArrayCount = 0
'inLevel = inLevel - 1
'For inCount = 0 To 5
'    chkSelect(inCount).Value = Val(stFilterInfo(inLevel, inArrayCount))
'    inArrayCount = inArrayCount + 1
'Next inCount

'For inCount = 0 To 23
'    txtSelection(inCount).Text = stFilterInfo(inLevel, inArrayCount)
'    inArrayCount = inArrayCount + 1
'Next inCount

'optAny(0).Value = stFilterInfo(inLevel, inArrayCount)
'inArrayCount = inArrayCount + 1
'optAll(0).Value = stFilterInfo(inLevel, inArrayCount)

'For inCount = 0 To 3
'    If inCount = inLevel Then inCount = inCount + 1
'    For inCountJ = 0 To 5
'        If stFilterInfo(inCount, inCountJ) = "1" Then
'               lblOther.Caption = "Other levels have active selection criteria!"
'        End If
'    Next inCountJ
'Next inCount

End Sub


Private Sub cmdScoreSheet_Click()
    frmFilter.Hide
    frmScoreSheet.Show

End Sub
```

```
Private Sub cmdStats_Click()
frmFilter.Hide
frmStats.Show
End Sub

Private Sub Form_Load()
'Center the form on the screen
frmFilter.Top = (Screen.Height - frmFilter.Height) / 2
frmFilter.Left = (Screen.Width - frmFilter.Width) / 2
'Set <Any> <All> option button defaults
optAll(0).Value = True
optAll(1).Value = True
ClearQueryForm
End Sub


'Function to build selection criteria info into an SQL string
Private Function BuildFilterLevel(ByVal inLevel As Integer, ByVal inNumCriteria As In
teger) As String
    'inLevel = upper (0) or lower (1) level
    'inNumCriteria = # of active selection criteria for given level
Dim stSubSQL As String          'SQL string to be returned (and then included in larger S
QL)
Dim stAndOr As String           'AND or OR depending on value of <Any> or <All> option bu
ttons
Dim inCount As Integer          'Counter
Dim inCriteria As Integer       'Current selection criteria index identifier
Dim stSelection, stOperator As String   'Selection criterion and selection operator t
ext values
Dim stType As String            'NULL string or single quote to identify values as numeri
cal or text
Dim vrLow, vrHigh As Variant     'Low and High values from form

    If optAny(inLevel).Value = "True" Then stAndOr = "OR" Else stAndOr = "AND"

    stSubSQL = "("

    'Step through the check boxes for each level (upper=0 to 5; lower=6 to 11)
    For inCount = inLevel * 6 To inLevel * 6 + 5
        'If selection criterion is "active" then add to SQL
        If chkSelect(inCount).Value = "1" Then
            inCriteria = inCriteria + 1
            stSubSQL = stSubSQL & "("
            stSelection = txtSelection(inCount + 0).Text
            stOperator = txtSelection(inCount + 12).Text
            rsOperator.MoveFirst
            'Search through operators from database to find a match
            While rsOperator.EOF <> True
                If rsOperator("Operator") = stOperator Then
                    'Convert stOperator to include the table and field references as
required
                    stOperator = rsOperator("Operator_Use")
                End If
                rsOperator.MoveNext
            Wend

            rsSelection.MoveFirst
            While rsSelection.EOF <> True
                If rsSelection("Filter") = stSelection Then
                    'Convert stSelection to include the table and field references as
 required
```

```
                    stSelection = rsSelection("Filter_Use")
                End If
                rsSelection.MoveNext
            Wend

            vrLow = StripCommas(txtSelection(inCount + 24).Text)
            vrHigh = StripCommas(txtSelection(inCount + 36).Text)
            'If <Low Value> is not a number, prepare to use single quotes
            If Val(vrLow) = 0 And vrLow <> "0" Then stType = "'" Else stType = ""
            stSubSQL = stSubSQL & " " & stSelection & " " & stOperator & " " & stType
 & vrLow
            'If operator requires a range, use both <Low Value> and <High Value>
            If InStr(stOperator, "BETWEEN") > 0 Then
                stSubSQL = stSubSQL & stType & " AND " & stType & vrHigh
            End If
            stSubSQL = stSubSQL & stType & ") "
            'If additional selection criteria exist for current level,
                'include AND or OR as appropriate
            If inCriteria < inNumCriteria Then
                stSubSQL = stSubSQL & " " & stAndOr & " "
            End If
        End If
    Next inCount

    stSubSQL = stSubSQL & ")"

    BuildFilterLevel = stSubSQL

End Function



Private Sub Form_Unload(Cancel As Integer)
'*** Code added by HelpWriter ***
    QuitHelp
'***********************************

    Dim inUserResponse As Integer    'Response from user
    Const conBtns As Integer = vbYesNo + vbExclamation + vbDefaultButton1 + vbApplica
tionModal

    'Prompt to make sure the user truly wants to exit
    inUserResponse = MsgBox("Do you want to exit?", conBtns, "Estimate Score Program"
)
    If inUserResponse = vbYes Then
        End
    Else
        Cancel = 1
    End If


End Sub




Public Sub optAll_Click(Index As Integer)
    'If not currently selected, select it
    If inAll(Index) = 0 Then
        inAll(Index) = 1
        'Enable/disable the command buttons to signify that
```

```
            'query results & query criteria are not the same
        cmdDoFilter.Enabled = True
        frmScoreSheet.cmdGraph.Enabled = False
        cmdGraph.Enabled = False
        cmdStats.Enabled = False
    End If

End Sub

Private Sub optAny_Click(Index As Integer)
    'If not currently selected, select it
    If inAll(Index) = 1 Then
        inAll(Index) = 0
        'Enable/disable the command buttons to signify that
            'query results & query criteria are not the same
        cmdDoFilter.Enabled = True
        frmScoreSheet.cmdGraph.Enabled = False
        cmdGraph.Enabled = False
        cmdStats.Enabled = False
    End If
End Sub


Private Sub optContingency_Click()
    'If not currently selected, select it
    If inNoContingency = 1 Then
        inNoContingency = 0
        'Enable/disable the command buttons to signify that
            'query results & query criteria are not the same
        cmdDoFilter.Enabled = True
        frmScoreSheet.cmdGraph.Enabled = False
        cmdGraph.Enabled = False
        cmdStats.Enabled = False
    End If

End Sub


Public Sub optNoContingency_Click()
    'If not currently selected, select it
    If inNoContingency = 0 Then
        inNoContingency = 1
        'Enable/disable the command buttons to signify that
            'query results & query criteria are not the same
        cmdDoFilter.Enabled = True
        frmScoreSheet.cmdGraph.Enabled = False
        cmdGraph.Enabled = False
        cmdStats.Enabled = False
    End If


End Sub


Private Sub txtSelection_Change(Index As Integer)
    'If <Selection Criteria Description>
    If Index <= 11 Then
        txtSelection(Index + 24).Text = ""
        txtSelection(Index + 36).Text = ""
    'If <Selection Operator>
    ElseIf Index <= 23 Then
        If InStr(txtSelection(Index).Text, "Range") > 0 Then
            txtSelection(Index - 12 + 36).Enabled = True
```

```
        Else
            txtSelection(Index - 12 + 36).Enabled = False
            txtSelection(Index - 12 + 36).Text = ""
        End If
    'If <Low Value> or <High Value>
    ElseIf Index <= 47 Then
    End If

    'Enable/disable the command buttons to signify that
        'query results & query criteria are not the same
    cmdDoFilter.Enabled = True
    frmScoreSheet.cmdGraph.Enabled = False
    cmdGraph.Enabled = False
    cmdStats.Enabled = False


End Sub

Private Sub txtSelection_Click(Index As Integer)
    Dim stCompare As String
    Dim inBaseIndex, inCboIndex As Integer

    inBaseIndex = Index
    inActiveIndex = Index
    'If <Selection Criteria Description>
    If Index <= 11 Then
        inCboIndex = Int(Index / 6)
        cboSelect(inCboIndex).Enabled = True
        Call FillCombo(cboSelect(inCboIndex), "Selection", "Filter", txtSelection(Ind
ex).Text)
        cboSelect(inCboIndex).SetFocus
    'If <Selection Operator>
    ElseIf Index <= 23 Then
        inCboIndex = Int(Index / 18)
        inBaseIndex = Index - 12
        cboSelect(inCboIndex).Enabled = True
        Call FillCombo(cboSelect(inCboIndex), "Operator", "Operator", txtSelection(In
dex).Text)
        cboSelect(inCboIndex).SetFocus
    'If <Low Value> or <High Value>
    ElseIf Index <= 47 Then
        'If <Low Value>
        If Index <= 35 Then
            stCompare = txtSelection(Index - 24).Text
            inBaseIndex = Index - 24
            inCboIndex = Int(Index / 30)
        'If <High Value>
        Else
            stCompare = txtSelection(Index - 36).Text
            inBaseIndex = Index - 36
            inCboIndex = Int(Index / 42)
        End If
        cboSelect(inCboIndex).Clear
        cboSelect(inCboIndex).Enabled = True
        txtSelection(Index).Locked = True
        'If stCompare represents a value that must be retrieved from a list from the
database
            'then retrieve the list and fill the combo box
        Select Case stCompare
            Case "Owner / Customer"
                Call FillCombo(cboSelect(inCboIndex), "Project", "Owner_Client", txtS
election(Index).Text)
                cboSelect(inCboIndex).SetFocus
```

```
            Case "Project Type"
                Call FillCombo(cboSelect(inCboIndex), "Project_Type", "Project_Type",
 txtSelection(Index).Text)
                cboSelect(inCboIndex).SetFocus
            Case "Project Sub-Type"
                Call FillCombo(cboSelect(inCboIndex), "Project_Type", "Project_Sub_Ty
pe", txtSelection(Index).Text)
                cboSelect(inCboIndex).SetFocus
            Case "Project Classification"
                Call FillCombo(cboSelect(inCboIndex), "Project", "Project_Disposition
", txtSelection(Index).Text)
                cboSelect(inCboIndex).SetFocus
            Case "Project Location"
                Call FillCombo(cboSelect(inCboIndex), "Project", "Project_Number", tx
tSelection(Index).Text)
                cboSelect(inCboIndex).SetFocus
            Case "Estimate Description"
                Call FillCombo(cboSelect(inCboIndex), "Estimate", "Estimate_Descripti
on", txtSelection(Index).Text)
                cboSelect(inCboIndex).SetFocus
            'Else disable the combo box and unlock the text box
            Case Else
                cboSelect(inCboIndex).Enabled = False
                txtSelection(Index).Locked = False
        End Select
    End If
End Sub


Private Sub txtSelection_LostFocus(Index As Integer)
    'If <Selection Criteria Description>
    If Index <= 11 Then
    'If <Selection Operator>
    ElseIf Index <= 23 Then
    'If <Low Value>
    ElseIf Index <= 35 Then
        If Val(txtSelection(Index).Text) > 0 Then
            'If a date is required, convert to data format
            If InStr(txtSelection(Index - 24).Text, "Date") > 0 Then
                txtSelection(Index).Text = Format(txtSelection(Index).Text, "mm/dd/yy
")
            'If a # is required, add commas (text will be left the same)
            Else
                txtSelection(Index).Text = AddCommas(txtSelection(Index).Text)
            End If
        End If
    'If <High Value>
    ElseIf Index <= 47 Then
        If Val(txtSelection(Index).Text) > 0 Then
            'If a date is required, convert to data format
            If InStr(txtSelection(Index - 36).Text, "Date") > 0 Then
                txtSelection(Index).Text = Format(txtSelection(Index).Text, "mm/dd/yy
")
            'If a # is required, add commas (text will be left the same)
            Else
                txtSelection(Index).Text = AddCommas(txtSelection(Index).Text)
            End If
        End If
    End If

End Sub
```

```
Private Sub ClearQueryForm()
Dim inCount As Integer

'Clear all check boxes and selection boxes
For inCount = 0 To 11
    chkSelect(inCount).Value = 0
    txtSelection(inCount).Enabled = False
    txtSelection(inCount).Locked = True
    txtSelection(inCount).Text = ""
    txtSelection(inCount + 12).Enabled = False
    txtSelection(inCount + 12).Locked = True
    txtSelection(inCount + 12).Text = ""
    txtSelection(inCount + 24).Enabled = False
    txtSelection(inCount + 24).Locked = True
    txtSelection(inCount + 24).Text = ""
    txtSelection(inCount + 36).Enabled = False
    txtSelection(inCount + 36).Locked = True
    txtSelection(inCount + 36).Text = ""
Next inCount

End Sub
```

frmGraphs - 1

```
Option Explicit
Public sgIntercept, sgSlope As Single     'For statistics computations
Public sgSumWXX, sgXbar As Single         'For statistics computations
Public sgMinX, sgMaxX As Single           'For warning message if ES is outside range


Private Sub OLSConfidenceIntervals()
    Dim inCount As Integer        'Counter
    Dim inResponse As Integer     'Users response from message box
    Dim inNumCIpoints As Integer     '# of points for probability band graphs
    Dim sgX, sgSumY, sgSumX, sgSumXY As Single  'For statistics calcs
    Dim sgYbar, sgY As Single     'For statistics calcs
    Dim sgSST As Single           'Sum of Squares Total
    Dim sgYHat As Single          'Predicted Y value
    Dim sgPlusMinus, sgUpperCL, sgLowerCL As Single 'For confidence limit calcs
    Dim dbTInv, dbAlpha As Double   't-statistic point value and its alpha

    'If <Below Upper Limit>, use one-tailed t-statistic
    If optBelow.Value = True Then
        dbAlpha = (1 - Val(txtConfidence.Text) / 100)
        dbTInv = TInv(dbAlpha, inNumProjects - 2)
    'If <Within Limits>, use two-tailed t-statistic
    Else
        dbAlpha = (1 - Val(txtConfidence.Text) / 100) / 2
        dbTInv = TInv(dbAlpha, inNumProjects - 2)
    End If

    sgErrorVarianceHat = sgSSE / (inNumProjects - 2)     'estimated variance
    inNumCIpoints = Int((grfScatter.NumPoints - 6) / 2)
    'Loop through and calculate points to create probability bands
    For inCount = 1 To inNumCIpoints
        sgX = 100 * (inCount - 1) * 1 / (inNumCIpoints - 2)
        sgYHat = sgIntercept + sgSlope * sgX
        sgC = sgSumXX - inNumProjects * sgXbar ^ 2
        If sgC > 0 Then
            sgPlusMinus = dbTInv * Sqr(sgErrorVarianceHat * (1 + 1 / inNumProjects +
(sgX - sgXbar) ^ 2 / sgC))
        End If
        'Draw next point for upper probability band
        grfScatter.OverlayXPos(inCount + 6) = sgX
        grfScatter.OverlayData(inCount + 6) = sgYHat + sgPlusMinus
        grfScatter.OverlayXPos(inCount + 6 + inNumCIpoints) = sgX
        'If <Within Limits>, draw next point for lower probability band
        If optWithin.Value = True Then
            grfScatter.OverlayData(inCount + 6 + inNumCIpoints) = sgYHat - sgPlusMinu
s
        'If <Below Upper Limit>, draw next point for upper probability band again
        Else
            grfScatter.OverlayData(inCount + 6 + inNumCIpoints) = sgYHat + sgPlusMinu
s
        End If
    Next inCount

    'Do not show overlay points not used for probability bands
    grfScatter.OverlayExtra(inNumCIpoints + 6) = 1
    grfScatter.OverlayExtra(grfScatter.NumPoints) = 1
    If grfScatter.NumPoints Mod 2 <> 0 Then
        grfScatter.OverlayExtra(grfScatter.NumPoints - 1) = 1
    End If

    sgX = Val(txtES.Text)
    sgYHat = sgIntercept + sgSlope * sgX    'predicted y value for current Estimate S
core
    sgC = sgSumXX - inNumProjects * sgXbar ^ 2
```

```
    If sgC > 0 Then
        sgPlusMinus = dbTInv * Sqr(sgErrorVarianceHat * (1 + 1 / inNumProjects + (sgX
 - sgXbar) ^ 2 / sgC))
    End If
    'Calculate and display point estimates of confidence limits
    If optWithin.Value = True Then
        txtLowerCL.Text = Format(sgYHat - sgPlusMinus, "   0.0%;  -0.0%")
    Else
        txtLowerCL.Text = "   N/A"
    End If
    txtUpperCL.Text = Format(sgYHat + sgPlusMinus, "   0.0%;  -0.0%")
    txtPredicted.Text = Format(sgYHat, "   0.0%;  -0.0%")

End Sub


Private Sub OLSCumulative()
    Dim sgX As Single               'X value (ES)
    Dim sgYHat As Single            'Predicted y value
    Dim sgPlusMinus  As Single      '+/- value for confidence limit calcs
    Dim dbAlpha As Double           'Alpha for t-distribution
    Dim dbTInv As Double            'Point value from t-distribution
    Dim inCount As Integer          'Counter

grfCumulative.NumPoints = 11
grfCumulative.AutoInc = 0

sgX = Val(txtES.Text)
sgYHat = sgIntercept + sgSlope * sgX
sgErrorVarianceHat = sgSSE / (inNumProjects - 2) 'predicted variance

If sgX > 0 Then
    dbAlpha = 1
    'Step through to calculate half of s-curve points (other half is same with differ
ent sign)
    For inCount = 5 To 10
        dbAlpha = dbAlpha * 0.5     'Alpha steps from 0.5 to 0.015625
        dbTInv = TInv(dbAlpha, inNumProjects - 2)   'Get t-distribution value
        If sgC > 0 Then
            sgPlusMinus = dbTInv * Sqr(sgErrorVarianceHat * (1 + 1 / inNumProjects +
(sgX - sgXbar) ^ 2 / sgC))
        End If
        'Calculate and display upper point
        grfCumulative.ThisPoint = 11 - inCount
        grfCumulative.XPosData = 1 - dbAlpha
        grfCumulative.GraphData = sgYHat + sgPlusMinus
        grfCumulative.PatternData = 2
        'Calculate and display lower point
        grfCumulative.ThisPoint = inCount + 1
        grfCumulative.XPosData = dbAlpha
        grfCumulative.GraphData = sgYHat - sgPlusMinus
        grfCumulative.PatternData = 2
    Next inCount
    grfCumulative.YAxisMin = sgYHat - sgPlusMinus
    grfCumulative.YAxisMax = sgYHat + sgPlusMinus
End If

Call ShowCI

End Sub


Private Function sgZScore(dbAlpha As Double) As Single
```

```
'Dim inCount As Integer
'Dim inSign As Integer

'inSign = 1

'Call LoadZScore

'If dbAlpha > 0.5 Then
'    inSign = -1
'    dbAlpha = dbAlpha - 0.5
'End If

'For inCount = 0 To 300
'    If dbNormal(inCount) > dbAlpha Then
'        Exit For
'    End If
'Next inCount

'sgZScore = inSign * inCount / 100

End Function

Public Sub cmdCalculate_Click()
'If no valid Estimate Score in text box, display message label and hide s-curve graph
If Val(txtES.Text) <= 0 Or Val(txtES.Text) > 100 Then
    lblCumulative.Visible = True
    grfCumulative.Visible = False
'If valid Estimate Score in text box, hide message label and display s-curve graph
Else
    lblCumulative.Visible = False
    grfCumulative.Visible = True
End If

Call CreateGraphs

'Disable command button to signify that graphs currently represent confidence limit c
riteria
cmdCalculate.Enabled = False

'If <Base Estimate> option selected, enable statistical info
If frmFilter.optContingency = False Then
    txtLowerCL.Enabled = True
    txtUpperCL.Enabled = True
    txtPredicted.Enabled = True
    lblRSquared.Enabled = True
    lblSlope.Enabled = True
    lblIntercept.Enabled = True
    lblStdError.Enabled = True
    If (Val(txtES.Text) > sgMaxX Or Val(txtES.Text) < sgMinX) And Val(txtES.Text) > 0
 Then
        stMSG = "For Estimate Score values outside the range of observed data," _
            & Chr(13) & Chr(10) & _
            "contingency predictions may be unreliable."
        inButtons = vbOKOnly + vbInformation + vbApplicationModal
        inResponse = MsgBox(stMSG, inButtons, "Estimate Score Outside of Range")

    End If
End If
End Sub


Private Sub cmdFilter_Click()
    frmFilter.Show
    frmGraphs.Hide
```

```
End Sub


Private Sub cmdExit_Click()
Call frmScoreSheet.cmdExit_Click

End Sub


Private Sub cmdPrint_Click()
Dim stMSG As String
Dim inButtons, inResponse As Integer

'If scatter graph tab active
If sstGraphs.Tab = 0 Then
    stMSG = "Click OK to print the scatter graph."
    inButtons = vbOKCancel + vbApplicationModal
    inResponse = MsgBox(stMSG, inButtons, "Print Scatter Graph")
    If inResponse = vbOK Then
        grfScatter.PrintStyle = 3
        grfScatter.PrintInfo(11) = 1
        grfScatter.PrintInfo(12) = 1
        grfScatter.DrawMode = 5
    End If
'If s-curve tab active
ElseIf sstGraphs.Tab = 1 Then
    stMSG = "Click OK to print the cumulative graph."
    inButtons = vbOKCancel + vbApplicationModal
    inResponse = MsgBox(stMSG, inButtons, "Print Cumulative Graph")
    If inResponse = vbOK Then
        grfCumulative.PrintStyle = 3
        grfCumulative.PrintInfo(11) = 1
        grfCumulative.PrintInfo(12) = 1
        grfCumulative.DrawMode = 5
    End If
End If
End Sub

Private Sub cmdScoreSheet_Click()
    frmGraphs.Hide
    frmScoreSheet.Show

End Sub

Private Function NoPointsMsg() As Integer

stMSG = "There are not enough data points to graph!" _
    & Chr(13) & Chr(10) & "Click <Edit Query> button to select data for graph." _
    & Chr(13) & Chr(10) & "And make sure there are at least 3 projects in the data se
t."

inButtons = vbOKOnly + vbInformation + vbApplicationModal
NoPointsMsg = MsgBox(stMSG, inButtons, "Not Enough Data Points")



End Function


Private Sub OrdinaryLS()
    Dim inCount As Integer        'Counter
    Dim inResponse As Integer     'User response to message box
```

```
    Dim sgX, sgSumY, sgSumX, sgSumXY, sgSumYY As Single 'For statistics calcs
    Dim sgYbar, sgY As Single   'For statistics calcs
    Dim sgSST As Single         'Sum of Squares Total
    Dim sgYHat As Single        'Predicted y value
    Dim sgRsquared As Single    'Coefficient of determination
    Dim sgPlusMinus, sgUpperCL, sgLowerCL As Single 'For confidence limit calcs
    Dim sgC As Single           'For confidence limit calcs

    sgSumY = 0
    sgSumX = 0
    sgSumXY = 0
    sgSumXX = 0
    sgSumYY = 0
    sgMaxY = 0
    sgMinY = 0
    sgMaxX = 0
    sgMinX = 100

    'Step through projects returned from query
    For inCount = 0 To inNumProjects - 1
        sgX = sgEScore(inCount)
        If sgX < sgMinX Then sgMinX = sgX
        If sgX > sgMaxX Then sgMaxX = sgX
        sgY = sgCostOverrun(inCount)
        If sgY > sgMaxY Then sgMaxY = sgY
        If sgY < sgMinY Then sgMinY = sgY
        sgSumX = sgSumX + sgX
        sgSumY = sgSumY + sgY
        sgSumXX = sgSumXX + sgX ^ 2
        sgSumYY = sgSumYY + sgY ^ 2
        sgSumXY = sgSumXY + sgX * sgY
        'Plot the point on the scatter graph
        grfScatter.ThisPoint = inCount + 1
        grfScatter.XPosData = sgX
        grfScatter.GraphData = sgY
    Next inCount
    sgYbar = sgSumY / inNumProjects     'Y average
    sgXbar = sgSumX / inNumProjects     'X average
    If inNumProjects > 1 Then
        sgSlope = (sgSumXY - inNumProjects * sgXbar * sgYbar) / (sgSumXX - inNumProje
cts * sgXbar ^ 2)
        sgIntercept = sgSumY / inNumProjects - sgSlope * sgSumX / inNumProjects
    Else
        sgSlope = 0
        sgIntercept = 0
    End If
    sgSST = 0
    sgSSE = 0   'Sum of Squares Error
    'Step through projects to compute Sum of Squares values
    For inCount = 0 To inNumProjects - 1
        sgX = sgEScore(inCount)
        sgY = sgCostOverrun(inCount)
        sgYHat = sgIntercept + sgSlope * sgX
        sgSST = sgSST + (sgY - sgYbar) ^ 2
        sgSSE = sgSSE + (sgY - sgYHat) ^ 2
    Next inCount
    If inNumProjects > 2 Then
        sgRsquared = ((inNumProjects * sgSumXY - sgSumX * sgSumY) / Sqr((inNumProject
s * sgSumXX - sgSumX * sgSumX) _
            * (inNumProjects * sgSumYY - sgSumY * sgSumY))) ^ 2
    End If
    If inNumProjects > 2 Then
        lblStdError.Caption = "Standard Error = " & Format(Sqr(sgSSE / (inNumProjects
 - 2)), "0.0000")
```

```
        lblSlope.Caption = "Slope = " & Format(sgSlope, "0.000")
        lblIntercept.Caption = "Intercept = " & Format(sgIntercept, "0.000")
        lblRSquared.Caption = "R-squared = " & Format(sgRsquared, "0.0%")
    Else
        lblStdError.Caption = "Standard Error = N/A"
        lblSlope.Caption = "Slope = N/A"
        lblIntercept.Caption = "Intercept = N/A"
        lblRSquared.Caption = "R-squared = N/A"
    End If
End Sub


Private Sub WLSConfidenceIntervals()
    Dim sgX As Single
    Dim sgYHat As Single
    Dim sgPlusMinus  As Single
    Dim dbAlpha As Double
    Dim dbTInv As Double
    Dim inCount As Integer

    'If <Below Upper Limit>, use one-tailed t-statistic
    If optBelow.Value = True Then
        dbAlpha = (1 - Val(txtConfidence.Text) / 100)
    'If <Base + Contingency>, use two-tailed t-statistic
    Else
        dbAlpha = (1 - Val(txtConfidence.Text) / 100) / 2
    End If
    dbTInv = TInv(dbAlpha, inNumProjects - 2)

    sgX = 100
    sgYHat = sgIntercept + sgSlope * sgX     'predicted y value
    sgPlusMinus = dbTInv * Sqr(sgErrorVarianceHat) * sgX
    'Compute and display upper confidence limit
    grfScatter.ThisPoint = 7
    grfScatter.OverlayXPosData = sgX
    grfScatter.OverlayGraphData = sgYHat + sgPlusMinus
    'Compute lower confidence limit
    grfScatter.ThisPoint = 9
    grfScatter.OverlayXPosData = sgX
    'If <Within Limits>, display lower confidence limit
    If optWithin.Value = True Then
        grfScatter.OverlayGraphData = sgYHat - sgPlusMinus
    'If <Below Upper Limit>, display upper confidence limit again
    Else
        grfScatter.OverlayGraphData = sgYHat + sgPlusMinus
    End If
    sgX = 0
    sgYHat = sgIntercept + sgSlope * sgX
    sgPlusMinus = dbTInv * Sqr(sgErrorVarianceHat) * sgX
    'Compute and display upper confidence limit
    grfScatter.ThisPoint = 8
    grfScatter.OverlayXPosData = sgX
    grfScatter.OverlayGraphData = sgYHat + sgPlusMinus
    'Do not display unused overlay points
    For inCount = 10 To grfScatter.NumPoints
        grfScatter.ThisPoint = inCount
        grfScatter.OverlayExtraData = 1
    Next inCount

    sgX = Val(txtES.Text)
    If sgX > 0 Then
        sgYHat = sgIntercept + sgSlope * sgX
        sgPlusMinus = dbTInv * Sqr(sgErrorVarianceHat) * sgX
        If optWithin.Value = True Then
```

```
            txtLowerCL.Text = Format(sgYHat - sgPlusMinus, "   0.0%;  -0.0%")
        Else
            txtLowerCL.Text = "   N/A"
        End If
        txtUpperCL.Text = Format(sgYHat + sgPlusMinus, "   0.0%;  -0.0%")
        txtPredicted.Text = Format(sgYHat, "   0.0%;  -0.0%")
    End If

End Sub


Private Sub WLSCumulative()
    Dim sgX As Single              'X value (ES)
    Dim sgYHat As Single           'Predicted y value
    Dim sgPlusMinus  As Single     '+/- value for confidence limit calcs
    Dim dbAlpha As Double          'Alpha for t-distribution
    Dim dbTInv As Double           'Point value from t-distribution
    Dim inCount As Integer         'Counter

grfCumulative.NumPoints = 11
grfCumulative.AutoInc = 0

sgX = Val(txtES.Text)
sgYHat = sgIntercept + sgSlope * sgX
sgErrorVarianceHat = sgSSE / (inNumProjects - 2)  'predicted variance

If sgX > 0 Then
    dbAlpha = 1
    'Step through to calculate half of s-curve points (other half is same with differ
ent sign)
    For inCount = 5 To 10
        dbAlpha = dbAlpha * 0.5      'Alpha steps from 0.5 to 0.015625
        dbTInv = TInv(dbAlpha, inNumProjects - 2)     'Get t-distribution value
        sgPlusMinus = dbTInv * Sqr(sgErrorVarianceHat) * sgX
        'Calculate and display upper point
        grfCumulative.ThisPoint = 11 - inCount
        grfCumulative.XPosData = 1 - dbAlpha
        grfCumulative.GraphData = sgYHat + sgPlusMinus
        grfCumulative.PatternData = 2
        'Calculate and display lower point
        grfCumulative.ThisPoint = inCount + 1
        grfCumulative.XPosData = dbAlpha
        grfCumulative.GraphData = sgYHat - sgPlusMinus
        grfCumulative.PatternData = 2
    Next inCount
    grfCumulative.YAxisMin = sgYHat - sgPlusMinus
    grfCumulative.YAxisMax = sgYHat + sgPlusMinus
End If

Call ShowCI
End Sub




Private Sub WeightedLS()
    Dim inCount, inStep As Integer  'Counters
    Dim inResponse As Integer       'User response from message box
    Dim sgX, sgY, sgW, sgSumWY, sgSumWX, sgSumWXY As Single 'For statistics calcs
    Dim sgSumY, sgSumX, sgSumXY, sgSumYY As Single         'For statistics calcs
    Dim sgYbar, sgSumW As Single    'For statistics calcs
    Dim sgSumXMinusXbar2 As Single  'For statistics calcs
    Dim sgYHat, sgSumWYMinusYprime2 As Single   'For statistics calcs
```

```
    Dim sgPlusMinus, sgUpperCL, sgLowerCL As Single 'For confidence limits calcs
    Dim sgC As Single   'For confidence limits calcs

    sgSumWY = 0
    sgSumWX = 0
    sgSumWXY = 0
    sgSumWXX = 0
    sgSumW = 0
    sgSumY = 0
    sgSumX = 0
    sgSumXY = 0
    sgSumXX = 0
    sgSumYY = 0
    sgMinY = 0
    sgMaxY = 0
    sgMinX = 100
    sgMaxX = 0

    'Step through projects returned from query
    For inCount = 0 To inNumProjects - 1
        sgX = sgEScore(inCount)
        If sgX < sgMinX Then sgMinX = sgX
        If sgX > sgMaxX Then sgMaxX = sgX
        sgY = sgCostOverrun(inCount)
        sgW = 1 / (sgX * sgX)
        If sgY > sgMaxY Then sgMaxY = sgY
        If sgY < sgMinY Then sgMinY = sgY
        sgSumW = sgSumW + sgW
        sgSumWX = sgSumWX + sgW * sgX
        sgSumWY = sgSumWY + sgW * sgY
        sgSumWXX = sgSumWXX + sgW * sgX ^ 2
        sgSumWXY = sgSumWXY + sgW * sgX * sgY
        'Plot the point on the scatter graph
        grfScatter.ThisPoint = inCount + 1
        grfScatter.XPosData = sgX
        grfScatter.GraphData = sgY
        sgSumX = sgSumX + sgX
        sgSumY = sgSumY + sgY
        sgSumXX = sgSumXX + sgX ^ 2
        sgSumYY = sgSumYY + sgY ^ 2
        sgSumXY = sgSumXY + sgX * sgY
    Next inCount
    sgSSE = 0   'Sum of Squares Error
    sgSlope = (sgSumWXY * sgSumW - sgSumWY * sgSumWX) / (sgSumWXX * sgSumW - sgSumWX
^ 2)
    sgIntercept = (sgSumWY - sgSlope * sgSumWX) / sgSumW
    'Step through projects to compute Sum of Squares values
    For inCount = 0 To inNumProjects - 1
        sgX = sgEScore(inCount)
        sgY = sgCostOverrun(inCount)
        sgW = 1 / (sgX * sgX)
        sgYHat = sgIntercept + sgSlope * sgX
        sgSSE = sgSSE + sgW * ((sgY - sgYHat) ^ 2)
    Next inCount
    sgErrorVarianceHat = sgSSE / (inNumProjects - 2)    'predicted variance
    For inCount = 1 To 6
        grfScatter.ThisPoint = inCount
        grfScatter.OverlayExtraData = 1
    Next inCount

    lblRSquared.Caption = "R-squared = N/A"
    If inNumProjects > 2 Then
        lblStdError.Caption = "Standard Error = " & Format(Sqr(sgErrorVarianceHat), "
0.0000")
```

```
    Else
        lblStdError.Caption = "Standard Error = "
    End If
    lblSlope.Caption = "Slope = " & Format(sgSlope, "0.000")
    lblIntercept.Caption = "Intercept = " & Format(sgIntercept, "0.000")

End Sub


Private Sub Form_Activate()

'Hide graphs and s-curve message
grfScatter.Visible = False
grfCumulative.Visible = False
lblCumulative.Visible = False

'If <Base + Contingency> option selected, disable confidence level & s-curve stuff
If frmFilter.optContingency = True Then
    sstGraphs.TabEnabled(1) = False
    sstGraphs.Tab = 0
    lblConfidence.Enabled = False
    txtConfidence.Enabled = False
    optBelow.Value = True
    grfScatter.OverlayPattern = 5
    grfScatter.OverlayColor = 0
    grfScatter.OverlayThickLines = 0
    spnConfidence.Enabled = False
    fraConfidence.Enabled = False
    fraConfidence2.Enabled = False
    optWithin.Enabled = False
    optBelow.Enabled = False
    optOLS.Enabled = False
    optOLS.Value = True
    optWLS.Enabled = False
    lblEstimateScore.Enabled = False
    lblUpper.Enabled = False
    lblPredicted.Enabled = False
    lblLower.Enabled = False
    txtES.Enabled = False
    txtLowerCL.Enabled = False
    txtUpperCL.Enabled = False
    txtPredicted.Enabled = False
    lblRSquared.Enabled = False
    lblSlope.Enabled = False
    lblIntercept.Enabled = False
    lblStdError.Enabled = False
    grfScatter.LeftTitle = "Cost Overrun" & Chr(10) & "(after Contingency)"
'If <Base Estimate> option selected, enable confidence level & s-curve stuff
ElseIf frmFilter.optContingency = False Then
    sstGraphs.TabEnabled(1) = True
    lblConfidence.Enabled = True
    txtConfidence.Enabled = True
    spnConfidence.Enabled = True
    fraConfidence.Enabled = True
    fraConfidence2.Enabled = True
    optWithin.Enabled = True
    optBelow.Enabled = True
    optOLS.Enabled = True
    optWLS.Enabled = True
    lblEstimateScore.Enabled = True
    lblUpper.Enabled = True
    lblPredicted.Enabled = True
    lblLower.Enabled = True
```

```
    txtES.Enabled = True
    txtLowerCL.Enabled = True
    txtUpperCL.Enabled = True
    txtPredicted.Enabled = True
    lblRSquared.Enabled = True
    lblSlope.Enabled = True
    lblIntercept.Enabled = True
    lblStdError.Enabled = True
    grfScatter.LeftTitle = "Contingency"
    grfScatter.OverlayPattern = 2
    grfScatter.OverlayColor = 4
    grfScatter.OverlayThickLines = 1
End If

If cmdCalculate.Enabled = True Then
    cmdCalculate_Click
Else
    grfScatter.Visible = True
    If Val(txtES.Text) <= 0 Or Val(txtES.Text) > 100 Then
        lblCumulative.Visible = True
        grfCumulative.Visible = False
    Else
        lblCumulative.Visible = False
        grfCumulative.Visible = True
    End If
End If

'If no Estimate Score has been filled in from the Estimate Score Sheet form,
    'allow user to enter an ES
If Val(frmScoreSheet.txtEScore.Text) = 0 Then
    txtES.Locked = False
'If an Estimate Score has been filled in from the Estimate Score Sheet form,
    'do not allow user to enter an ES
Else
    txtES.Locked = True
End If
End Sub

Public Sub CreateGraphs()
Dim inCount As Integer

lblRSquared = "R-squared = "
lblSlope = "Slope = "
lblStdError = "Standard Error = "
lblIntercept = "Intercept = "
grfScatter.IndexStyle = 1
grfScatter.AutoInc = 0
grfScatter.NumSets = 1
grfScatter.ThisSet = 1
grfScatter.ThisPoint = 1
grfScatter.PatternData = 5
grfScatter.SymbolData = 9
grfScatter.DataReset = 1
grfScatter.DataReset = 3
grfScatter.DataReset = 8
grfScatter.DataReset = 19
grfScatter.DataReset = 23
grfScatter.DataReset = 24
If inNumProjects > 0 Then
    grfScatter.NumPoints = inNumProjects
    If grfScatter.NumPoints < 20 Then
        'Increase .NumPoints to 20 for probability bands with overlay data
        grfScatter.NumPoints = 20
        For inCount = inNumProjects To 20
```

```
            'Do not display the overlay points until their needed
            grfScatter.Extra(inCount) = 2
        Next inCount
    End If
End If
grfCumulative.XAxisStyle = 2
grfCumulative.XAxisMin = 0
grfCumulative.XAxisMax = 1
grfCumulative.XAxisTicks = 5
grfCumulative.YAxisStyle = 0
grfScatter.XAxisStyle = 2
grfScatter.XAxisMin = 0
grfScatter.XAxisMax = 100
grfScatter.LabelXFormat = "0"
grfScatter.XAxisTicks = 5
grfScatter.YAxisStyle = 0

'Calculate statistics, probability bands and cumulative s-curve for selected option
If optOLS.Value = True Then
    Call OrdinaryLS
    Call OLSConfidenceIntervals
    Call OLSCumulative
ElseIf optMLE.Value = True Then
'    Call MaxLikelihood
'    Call MLEConfidenceIntervals
'    Call MLECumulative
ElseIf optWLS.Value = True Then
    Call WeightedLS
    Call WLSConfidenceIntervals
    Call WLSCumulative
End If

'Do not display first 6 points (ES line and average prediction line)
For inCount = 1 To 6
    grfScatter.OverlayExtra(inCount) = 1
Next inCount
'Calculate ES line
grfScatter.YAxisMin = sgMinY
grfScatter.YAxisMax = sgMaxY
grfScatter.OverlayXPos(1) = Val(txtES.Text)
grfScatter.OverlayData(1) = grfScatter.YAxisMin
grfScatter.OverlayXPos(2) = Val(txtES.Text)
grfScatter.OverlayData(2) = grfScatter.YAxisMax
'Calculate slope/intercept line (average prediction line)
grfScatter.OverlayXPos(4) = 1
grfScatter.OverlayData(4) = sgIntercept + 1 * sgSlope
grfScatter.OverlayXPos(5) = 0
grfScatter.OverlayData(5) = sgIntercept
grfScatter.OverlayExtra(3) = 1
grfScatter.OverlayExtra(6) = 1
'Refresh/redraw the graphs
grfScatter.DrawMode = 2
grfCumulative.DrawMode = 2

'If not enough points returned from query, display error message
    'and hide graphs
If inNumProjects <= 2 Then
    inResponse = NoPointsMsg
    grfScatter.Visible = False
    grfCumulative.Visible = False
    lblCumulative.Visible = False
    Exit Sub
'If enough points returned from query, display graphs
Else
```

```
    grfScatter.Visible = True
    If Val(txtES.Text) <= 0 Or Val(txtES.Text) > 100 Then
        lblCumulative.Visible = True
        grfCumulative.Visible = False
    Else
        lblCumulative.Visible = False
        grfCumulative.Visible = True
    End If
End If



End Sub

Private Sub Form_Load()
    'Center form on screen
    frmGraphs.Top = (Screen.Height - frmGraphs.Height) / 2
    frmGraphs.Left = (Screen.Width - frmGraphs.Width) / 2

End Sub

Private Sub Form_Unload(Cancel As Integer)
'*** Code added by HelpWriter ***
    QuitHelp
'***********************************

    Dim inUserResponse As Integer   'Response from user
    Const conBtns As Integer = vbYesNo + vbExclamation + vbDefaultButton1 + vbApplica
tionModal

    'Prompt to make sure the user truly wants to exit
    inUserResponse = MsgBox("Do you want to exit?", conBtns, "Estimate Score Program"
)
    If inUserResponse = vbYes Then
        End
    Else
        Cancel = 1
    End If


End Sub

Private Sub optMLE_Click()
    'If not current method, make current and disable OLS info
    If inMethod <> 2 Then
        inMethod = 2
        cmdCalculate.Enabled = True
        txtLowerCL.Enabled = False
        txtUpperCL.Enabled = False
        txtPredicted.Enabled = False
        lblRSquared.Enabled = False
        lblSlope.Enabled = False
        lblIntercept.Enabled = False
        lblStdError.Enabled = False
    End If

End Sub

Public Sub optOLS_Click()
    'If not current method, make current and enable OLS info
    If inMethod <> 1 Then
        inMethod = 1
        cmdCalculate.Enabled = True
        txtLowerCL.Enabled = False
```

```
        txtUpperCL.Enabled = False
        txtPredicted.Enabled = False
        lblRSquared.Enabled = False
        lblSlope.Enabled = False
        lblIntercept.Enabled = False
        lblStdError.Enabled = False
    End If

End Sub

Private Sub optBelow_Click()
    'If not selected, select it and ...
    If inWithin = 1 Then
        inWithin = 0
        'Update confidence level from two-tailed to one-tailed
        txtConfidence.Text = 100 - (100 - Val(txtConfidence.Text)) / 2
        'Enable/disable controls to signify that graphs do not show currently selecte
d options
        cmdCalculate.Enabled = True
        txtLowerCL.Enabled = False
        txtUpperCL.Enabled = False
        'txtPredicted.Enabled = False
        'lblRSquared.Enabled = False
        'lblSlope.Enabled = False
        'lblIntercept.Enabled = False
        'lblStdError.Enabled = False
    End If

End Sub

Private Sub optWLS_Click()
    'If not current method, make current, enable WLS info and disable OLS info
    If inMethod <> 0 Then
        inMethod = 0
        cmdCalculate.Enabled = True
        txtLowerCL.Enabled = False
        txtUpperCL.Enabled = False
        txtPredicted.Enabled = False
        lblRSquared.Enabled = False
        lblSlope.Enabled = False
        lblIntercept.Enabled = False
        lblStdError.Enabled = False
    End If

End Sub

Public Sub optWithin_Click()
    'If not selected, select it and ...
    If inWithin = 0 Then
        inWithin = 1
        'Update confidence level from one-tailed to two-tailed
        txtConfidence.Text = 100 - (100 - Val(txtConfidence.Text)) * 2
        'Enable/disable controls to signify that graphs do not show currently selecte
d options
        cmdCalculate.Enabled = True
        txtLowerCL.Enabled = False
        txtUpperCL.Enabled = False
        'txtPredicted.Enabled = False
        'lblRSquared.Enabled = False
        'lblSlope.Enabled = False
        'lblIntercept.Enabled = False
        'lblStdError.Enabled = False
    End If
End Sub
```

```
Private Sub spnConfidence_SpinDown()
    Dim newVal As Integer

    'Decrement confidence level by five
    newVal = Val(txtConfidence.Text) - 5
    If newVal >= 0 And newVal <= 100 Then
        txtConfidence.Text = newVal
    End If

End Sub

Private Sub spnConfidence_SpinUp()
    Dim newVal As Integer

    'Increment confidence level by five
    newVal = Val(txtConfidence.Text) + 5
    If newVal > 0 And newVal <= 100 Then
        txtConfidence.Text = newVal
    End If


End Sub




Private Sub txtConfidence_Change()

'Make sure confidence level stays within allowable range
    If Val(txtConfidence.Text) >= 100 Then
        txtConfidence.Text = 99.9
    Else
        If Val(txtConfidence.Text) < 0 Then txtConfidence.Text = 0
    End If

    'Enable/disable controls to signify that graphs do not show currently selected op
tions
    cmdCalculate.Enabled = True
    txtLowerCL.Enabled = False
    txtUpperCL.Enabled = False
    'txtPredicted.Enabled = False
    'lblRSquared.Enabled = False
    'lblSlope.Enabled = False
    'lblIntercept.Enabled = False
    'lblStdError.Enabled = False

End Sub


'Subroutine to display probability bands
Private Sub ShowCI()
    Dim inCount As Integer
    Dim sgCLx, sgCUx As Single


    grfCumulative.OverlayGraphStyle = 0
    grfCumulative.ThickLines = 1
    grfCumulative.OverlayThickLines = 1
    grfCumulative.OverlayPattern = 2
    grfCumulative.OverlayColor = 4
    grfCumulative.OverlayExtra(3) = 1
```

```
    'If <Below Upper Limit>, lower limit is meaningless
    If optBelow.Value = True Then
        sgCLx = 0
        sgCUx = Val(txtConfidence.Text) / 100
        grfCumulative.OverlayExtra(4) = 1
        grfCumulative.OverlayExtra(5) = 1
    'If <Within Limits>, ...
    Else
        grfCumulative.OverlayExtra(4) = 0
        grfCumulative.OverlayExtra(5) = 0
        sgCLx = (100 - Val(txtConfidence.Text)) / 2 / 100
        sgCUx = (100 - (100 - Val(txtConfidence.Text)) / 2) / 100
        grfCumulative.ThisPoint = 4
        grfCumulative.OverlayXPosData = sgCLx
        grfCumulative.OverlayGraphData = grfCumulative.YAxisMin
        grfCumulative.ThisPoint = 5
        grfCumulative.OverlayXPosData = sgCLx
        grfCumulative.OverlayGraphData = grfCumulative.YAxisMax
    End If
    grfCumulative.ThisPoint = 1
    grfCumulative.OverlayXPosData = sgCUx
    grfCumulative.OverlayGraphData = grfCumulative.YAxisMin
    grfCumulative.ThisPoint = 2
    grfCumulative.OverlayXPosData = sgCUx
    grfCumulative.OverlayGraphData = grfCumulative.YAxisMax
    'Do not display first 6 points (ES line and predicted average line)
    For inCount = 6 To grfCumulative.NumPoints
        grfCumulative.OverlayExtra(inCount) = 1
    Next inCount



End Sub

Private Sub txtES_Change()
'Enable/disable controls to signify that graphs do not show currently selected option
s
    cmdCalculate.Enabled = True
    txtLowerCL.Enabled = False
    txtUpperCL.Enabled = False
    txtPredicted.Enabled = False
End Sub

Private Sub txtES_LostFocus()
'Reformat the ES text box
    If Val(txtES.Text) <= 0 Then txtES.Text = "    0.0"
    If Val(txtES.Text) >= 100 Then
        txtES.Text = "  100.0"
    ElseIf Val(txtES.Text) >= 10 Then
        txtES.Text = Format(txtES.Text, "   00.0")
    Else
        txtES.Text = Format(txtES.Text, "    0.0")
    End If
End Sub
```

frmIntro - 1

```
Option Explicit

Private Sub Form_Load()
    frmIntro.MousePointer = 11
    Picture1.Top = (Screen.Height - Picture1.Height) / 2 - 600
    Picture1.Left = (Screen.Width - Picture1.Width) / 2 + 600
    Picture2.Top = (Screen.Height - Picture2.Height) / 2 - 600
    Picture2.Left = Picture1.Left - 1200
End Sub

Private Sub Timer1_Timer()
    frmScoreSheet.Show
    frmIntro.Hide
    Timer1.Enabled = False
End Sub
```

```
Option Explicit

Dim rsProject As Recordset      ' Project info for active project
Dim rsEstimateIDs As Recordset  ' Estimate IDs for active project
Dim rsEstimate As Recordset     ' Estimate (or Actual) info for active estimate
Dim stSQL As String             'SQL for querying database
Dim stProjectID As String       'Project identifier
Dim stEstimateID As String      'Estimate identifier
Dim inEstimateID As Integer     'Estimate identifier

Private Function ChangesMsg() As Integer

stMSG = "You have made changes to Project '" & stProjectName _
    & " Estimate #" & stEstimateID & "'!" & Chr(13) & Chr(10) _
    & "These changes have not been saved to the database!" _
    & Chr(13) & Chr(10) & "Do you want to save the changes before continuing?"

inButtons = vbYesNoCancel + vbQuestion + vbDefaultButton1 + vbApplicationModal
ChangesMsg = MsgBox(stMSG, inButtons, "Save Changes?")

End Function


Sub ShowToolTip()
Dim showtipnow As Integer

'If ToolTip is already visible, exit the subroutine
If frmToolTip.Visible = True And frmToolTip.lblTooltip.Caption = stTip Then Exit Sub

'Create and display the applicable ToolTip
frmToolTip.lblTooltip.Caption = stTip
frmToolTip.Height = frmToolTip.lblTooltip.Height
frmToolTip.Width = frmToolTip.lblTooltip.Width
frmToolTip.Top = sgToolTop
If sgToolLeft + frmToolTip.Width < Screen.Width Then
    frmToolTip.Left = sgToolLeft
Else
    frmToolTip.Left = Screen.Width - frmToolTip.Width
End If

'Only show ToolTip if <Show ToolTips> is checked
If chktooltip.Value = 1 Then
    frmToolTip.Visible = True
End If
End Sub
Private Sub ClearData()
Dim inCount, inCountJ As Integer     'Counters
Dim inOptNum As Integer              'Option button # = deeo (d=div; e=element; o=opti
on button)
Dim inScoreBoxNum As Integer         'Score box # = dee (d=div; e=element)

cboType.Clear
cboSub.Clear
cbodispos.Clear
cboType.Enabled = False
cboSub.Enabled = False
cbodispos.Enabled = False

tabInput.Tab = 0

'Disable division tabs
For inCount = 1 To 4
    tabInput.TabEnabled(inCount) = False
Next inCount
```

```
'Disable estimate text boxes
For inCount = 0 To 17
    txtEstimate(inCount).Text = ""
    txtEstimate(inCount).Enabled = False
Next inCount

'Disable project text boxes
For inCount = 0 To 4
    txtProject(inCount).Text = ""
    txtProject(inCount).Enabled = False
Next inCount

'Zero out division score text boxes
For inCount = 1 To 4
    txtDivScore(inCount).Text = -1
    txtDivScore(inCount).Text = ""
    txtDivScore(inCount).Tag = -1
    txtDivScore(inCount).Tag = ""
Next inCount

'Reset labels to reflect "Estimate" and not "Actual"
lblDate = "Estimate Date:"
lblEstimate = "ESTIMATED COST ($)"
chkExtenuating.Value = 0
chkExtenuating.Enabled = False
chkExtenuating.Visible = True
txtPercentContingency.Text = ""
txtPercentContingency.Enabled = False
txtPercentContingency.Visible = True
lblPercentContingency.Visible = True

'Change all element ratings to 5 (five)
For inCount = 1 To 4
    For inCountJ = 1 To inDivCount(inCount)
        inOptNum = inCount * 1000 + inCountJ * 10 + 5   'this 5 = default value
        inScoreBoxNum = inCount * 100 + inCountJ
        optERI(inOptNum).Value = True
        txtERI(inScoreBoxNum).Text = optERI(inOptNum).Tag
    Next inCountJ
    txtDivScore(inCount).Text = ""
Next inCount

sgDivScore(0) = 0
sgDivPossible(0) = 0

'Zero out division score arrays
For inCount = 1 To 4
    sgDivScore(inCount) = 0
    sgDivPossible(inCount) = 0
Next inCount

'Call change subroutines to recalculate Estimate Score totals as zero
Call txtERI_Change(101)
Call txtERI_Change(201)
Call txtERI_Change(301)
Call txtERI_Change(401)
Call txtDivScore_Change(1)
Call txtDivScore_Change(2)
Call txtDivScore_Change(3)
Call txtDivScore_Change(4)

'Disable command button to signify that no changes have been made
cmdSaveData.Enabled = False
```

```
End Sub
'Function to save NULL value as NULL text string
Private Function TxtAssign(vrValue As Variant) As String
    If IsNull(vrValue) Then
        TxtAssign = ""
    Else
        TxtAssign = vrValue
    End If

End Function
```

```
Private Sub cbodispos_Change()
'Enable command button to signify that changes have been made
    cmdSaveData.Enabled = True

End Sub

'Subroutine to retrieve data from database and fill out Estimate Score Sheet form
Private Sub FillData(stEstimateID As String)
Dim stES As String        'Element # = ES_d_ee (d=div; e=element)
Dim inES As Integer       'Element # = ddee (d=div; e=element)
Dim inElementRating As Integer       'Element rating (0 - 5)
Dim inESopt As Integer               'Element rating option button deer (d=div; e=elem
ent; r=rating (0 - 5))
Dim inCount, inCountJ As Integer     'Counters

'Zero out division score totals
For inCount = 0 To 4
    sgDivScore(inCount) = 0
    sgDivPossible(inCount) = 0
Next inCount

'Enable estimate text boxes
For inCount = 0 To 17
    txtEstimate(inCount).Enabled = True
Next inCount
'Enable %contingency text box
txtPercentContingency.Enabled = True
'Enable <Extenuating Circum> check box
chkExtenuating.Enabled = True
'Enable project text boxes
For inCount = 0 To 4
    txtProject(inCount).Enabled = True
Next inCount
'Enable project combo boxes
cboType.Enabled = True
cbodispos.Enabled = True
cboSub.Enabled = True
```

```
cboType.Clear
cbodispos.Clear
cboSub.Clear
'Fill project type combo box with allowable project types
Call FillCombo(cboType, "ProjectCombo", "Project_Type", cboType.Text)

inRCount = rsProject.RecordCount

'Fill in project info from database
If inRCount > 0 Then
    txtProject(1).Text = TxtAssign(rsProject("company_name"))
    txtProject(2).Text = TxtAssign(rsProject("contact_person"))
    txtProject(3).Text = TxtAssign(rsProject("contact_number"))
    txtProject(0).Text = TxtAssign(rsProject("project_number"))
    txtProject(4).Text = TxtAssign(rsProject("owner_client"))
    If TxtAssign(rsProject("project_type")) <> "" Then
        cboType.Text = TxtAssign(rsProject("project_type"))
        stProjectType = cboType.Text
    End If
End If

'Fill project sub-type combo box with allowable project sub-types
Call FillCombo(cboSub, "ProjectCombo", cboType.Text, cboSub.Text)
'Fill project classification combo box with allowable project classifications
Call FillCombo(cbodispos, "ProjectCombo", "Project_Disposition", cbodispos.Text)

'Fill in project info from database
If inRCount > 0 Then
    If TxtAssign(rsProject("project_sub_type")) <> "" Then
        cboSub.Text = TxtAssign(rsProject("project_sub_type"))
        stProjectSub = cboSub.Text
    End If
    If TxtAssign(rsProject("project_disposition")) <> "" Then
        cbodispos.Text = TxtAssign(rsProject("project_disposition"))
        stProjectDispos = cbodispos.Text
    End If
End If


If stEstimateID = "Actual" Then
    inEstimateID = 999
ElseIf stEstimateID <> "New Estimate" Then
    inEstimateID = Val(stEstimateID)
Else
    inEstimateID = inNumEstimates + 1
End If

'If "estimate" is not "Acutal", enable the division tabs, fill ES info and calc ES
If inEstimateID <> 999 Then
    For inCount = 1 To 4
        tabInput.TabEnabled(inCount) = True
    Next inCount

    'Query the estimate table
    stSQL = "SELECT * FROM Estimate " _
        & " WHERE (Project_ID = " & stProjectID & ")" _
        & " AND (Estimate_ID = " & inEstimateID & ")"

    Set rsEstimate = dbES.OpenRecordset(stSQL, dbOpenDynaset)

    'If the user is creating a new estimate,
        'save defaults for new estimate to the database
    If stEstimateID = "New Estimate" Then
```

```
        stEstimateID = inNumEstimates + 1
        inNewFlag = 1
        inNumEstimates = inNumEstimates + 1
        cboEstimate.AddItem stEstimateID
        cboEstimate.Text = stEstimateID
        rsEstimate.AddNew
        rsEstimate!Project_ID = rsProject!Project_ID
        rsEstimate!estimate_id = inEstimateID
        rsEstimate.Update
        rsEstimate.MoveLast
        Exit Sub
    End If

    inRCount = rsEstimate.RecordCount

    'Get estimate info from database and fill in estimate text boxes
    If inRCount > 0 Then
        txtEstimate(0).Text = TxtAssign(rsEstimate("estimate_description"))
        txtEstimate(1).Text = TxtAssign(rsEstimate("estimate_date"))
        txtEstimate(2).Text = TxtAssign(rsEstimate("chief_estimator"))
        txtEstimate(3).Text = AddCommas(TxtAssign(rsEstimate("Estimated_Engineering_D
esign")))
        txtEstimate(4).Text = AddCommas(TxtAssign(rsEstimate("Estimated_Engineered_Eq
uipment")))
        txtEstimate(5).Text = AddCommas(TxtAssign(rsEstimate("Estimated_Construction"
)))
        txtEstimate(6).Text = AddCommas(TxtAssign(rsEstimate("Estimated_Other_Costs")
))
        txtEstimate(7).Text = AddCommas(TxtAssign(rsEstimate("Estimated_Owner_Costs")
))
        txtEstimate(8).Text = AddCommas(TxtAssign(rsEstimate("contingency")))
        txtEstimate(10).Locked = False
        txtEstimate(11).Locked = False
        txtEstimate(12).Locked = False
        txtEstimate(13).Locked = False
        txtEstimate(14).Locked = False
        txtEstimate(10).Text = TxtAssign(rsEstimate("Business_Unit_Study"))
        txtEstimate(11).Text = TxtAssign(rsEstimate("Preliminary_Engineering"))
        txtEstimate(12).Text = TxtAssign(rsEstimate("Detailed_Engineering"))
        txtEstimate(13).Text = TxtAssign(rsEstimate("Procurement"))
        txtEstimate(14).Text = TxtAssign(rsEstimate("Construction"))
        txtEstimate(15).Text = TxtAssign(rsEstimate("Estimated_Other_Costs_Descriptio
n"))
        txtEstimate(16).Text = AddCommas(TxtAssign(rsEstimate("Estimated_Bulk_Materia
ls")))
        txtEstimate(17).Text = TxtAssign(rsEstimate("Estimate_Comments"))
        If rsEstimate("Extenuating") = 0 Then
            chkExtenuating.Value = 0
        Else
            chkExtenuating.Value = 1
        End If

        txtEstimate_LostFocus (8)

        sgDivPossible(0) = 0
        'Calculate Estimate Score
        For inCount = 1 To 4
            sgDivPossible(inCount) = 0
            For inCountJ = 1 To inDivCount(inCount)
                inES = 100 * inCount + inCountJ
                stES = "ES_" & CStr(inCount) & "_" & CStr(inCountJ)
                inElementRating = Val(TxtAssign(rsEstimate(stES)))
                If inElementRating < 1 Then
                    inElementRating = 1
```

```
                ElseIf inElementRating > 5 Then
                    inElementRating = 5
                End If
                inESopt = inES * 10 + inElementRating
                optERI(inESopt).Value = True
'                If optERI(inES * 10).Value = False Then
                    sgDivScore(inCount) = sgDivScore(inCount) + Val(txtERI(inES).Text
)
                    sgDivPossible(inCount) = sgDivPossible(inCount) + Val(optERI(inES
 * 10 + 5).Tag)
'                End If
            Next inCountJ
            sgDivPossible(0) = sgDivPossible(0) + sgDivPossible(inCount)
        Next inCount
    End If

'If "estimate" is for "Actual" costs
Else
    'Query the completed projects table
    stSQL = "SELECT * FROM Completed_Project " _
        & " WHERE (Project_ID = " & stProjectID & ")"
    Set rsEstimate = dbES.OpenRecordset(stSQL, dbOpenDynaset)

    inRCount = rsEstimate.RecordCount

    'Retrieve actual cost data and fill in estimate text boxes
    If inRCount > 0 Then
        txtEstimate(0).Text = "Actual Costs"
        lblDate = "Completion Date:"
        lblEstimate = "ACTUAL COST ($)"
        chkExtenuating.Visible = False
        txtPercentContingency.Visible = False
        lblPercentContingency.Visible = False
        txtEstimate(1).Text = TxtAssign(rsEstimate("Actual_Completion"))
        txtEstimate(2).Text = "N/A"
        txtEstimate(2).Enabled = False
        txtEstimate(3).Text = AddCommas(TxtAssign(rsEstimate("Actual_Engineering_Desi
gn")))
        txtEstimate(4).Text = AddCommas(TxtAssign(rsEstimate("Actual_Engineered_Equip
ment")))
        txtEstimate(5).Text = AddCommas(TxtAssign(rsEstimate("Actual_Construction")))
        txtEstimate(6).Text = AddCommas(TxtAssign(rsEstimate("Actual_Other_Costs")))
        txtEstimate(7).Text = AddCommas(TxtAssign(rsEstimate("Actual_Owner_Costs")))
        txtEstimate(8).Text = "                    N/A"
        txtEstimate(8).Enabled = False
        txtEstimate(10).Text = "100"
        txtEstimate(11).Text = "100"
        txtEstimate(12).Text = "100"
        txtEstimate(13).Text = "100"
        txtEstimate(14).Text = "100"
        txtEstimate(10).Locked = True
        txtEstimate(11).Locked = True
        txtEstimate(12).Locked = True
        txtEstimate(13).Locked = True
        txtEstimate(14).Locked = True
        txtEstimate(15).Text = TxtAssign(rsEstimate("Actual_Other_Costs_Description")
)
        txtEstimate(16).Text = AddCommas(TxtAssign(rsEstimate("Actual_Bulk_Materials"
)))
        txtEstimate(17).Text = TxtAssign(rsEstimate("Actual_Comments"))
    End If
End If

'Call LostFocus subroutines to invoke routine to place commas in text boxes
```

```
For inCount = 3 To 7
    txtEstimate_LostFocus (inCount)
Next inCount
For inCount = 9 To 14
    txtEstimate_LostFocus (inCount)
Next inCount
txtEstimate_LostFocus (16)

'Disable command button to signify that no changes need to be saved
cmdSaveData.Enabled = False

End Sub

Private Sub cbodispos_LostFocus()
If stProjectDispos <> cbodispos.Text Then
    'Enable command button to signify that changes have been made
    cmdSaveData.Enabled = True
End If

End Sub

Private Sub cboEstimate_Click()
Dim inResponse As Integer   'User response to message box
Dim stES As String          'Estimate # = ES_d_ee (d=div; e=element)
Dim inES As Integer         'Estimate # = ddee (d=div; e=element)
Dim inESopt As Integer      'Element rating (0 - 5)
Dim inCount As Integer      'Counter
Dim inActualFLAG As Integer 'FLAG if "estimate" is "Actual"

'If changes have been made and user wants to change to a different estimate, ...
If cmdSaveData.Enabled = True And stEstimateID <> cboEstimate.Text And inNewFlag <> 1
 Then
    'Prompt to see if user wants to save changes before continuing
    inResponse = ChangesMsg
    If inResponse = vbNo Then
        Call ClearData
    ElseIf inResponse = vbYes Then
        cmdSaveData_Click
    Else
        cboEstimate.Text = stEstimateID
        Exit Sub
    End If
End If

'If user wants to create a new estimate
If cboEstimate.Text = "New Estimate" Then
    inActualFLAG = 0
    'If "Actual" shows up on list, FLAG it so that user cannot create 2 "Actual" reco
rds
    For inCount = 0 To cboEstimate.ListCount
        If cboEstimate.List(inCount) = "Actual" Then inActualFLAG = 1
    Next inCount

    If inActualFLAG = 0 Then
        'See if user wants to record "Actual" costs
        stMSG = "Will the new 'estimate' be ACTUAL costs?"
        inButtons = vbYesNoCancel + vbQuestion + vbDefaultButton2 + vbApplicationModa
l
        inResponse = MsgBox(stMSG, inButtons, "Actual Costs?")
        If inResponse = vbYes Then
            cboEstimate.AddItem "Actual"
            cboEstimate.Text = "Actual"
            inEstimateID = 999
        ElseIf inResponse = vbCancel Then
```

```
            Call cboName_LostFocus
            Exit Sub
        End If
    End If
    'Clear the data from the Estimate Score Sheet form
    Call ClearData
    'Retrieve the data (activate all the data fields)
    Call cmdGetData_Click
    If inRCount = 0 And cboEstimate.Text = "Actual" Then
        txtEstimate(0).Text = "Actual Costs"
        lblDate = "Completion Date:"
        lblEstimate = "ACTUAL COST ($)"
        chkExtenuating.Visible = False
        txtPercentContingency.Visible = False
        lblPercentContingency.Visible = False
        txtEstimate(2).Text = "N/A"
        txtEstimate(2).Enabled = False
        txtEstimate(8).Text = "                N/A"
        txtEstimate(8).Enabled = False
        For inCount = 10 To 14
            txtEstimate(inCount).Text = "100"
            txtEstimate(inCount).Locked = True
            txtEstimate_LostFocus (inCount)
        Next inCount
        txtEstimate_LostFocus (16)
    End If
    '"Save" the new data
    Call cmdSaveData_Click
End If

stEstimateID = cboEstimate.Text

txtEstimate(0).Refresh
txtEstimate(1).Refresh



End Sub

Private Sub cboEstimate_LostFocus()
Dim inCheckEst As Integer   'Check to see if "estimate" is "Actual" costs

'If estimate is not a new estimate
If cboEstimate.Text <> "New Estimate" Then
    frmScoreSheet.Caption = "ESTIMATE SCORE SHEET for Project '" & _
        stProjectName & "' Estimate #" & cboEstimate.Text
    If cboEstimate.Text = "Actual" Then
        inCheckEst = 999
    Else
        inCheckEst = Val(cboEstimate.Text)
    End If
    'If selected estimate is not same as the estimate displayed on the Estimate Score
 Sheet form, ...
    If inCheckEst <> inEstimateID Then
        'If project and estimate info are shown on Estimate Score Sheet form, ...
        If txtProject(0).Enabled = True Then
            'If changes have been made that need to be saved, ...
            If cmdSaveData.Enabled = True Then
                'See if user wants to save changes before continuing
                inResponse = ChangesMsg
                If inResponse = vbNo Then
                    'Clear the form
                    Call ClearData
                ElseIf inResponse = vbYes Then
```

```
                    'Save the data and clear the form
                    cmdSaveData_Click
                    Call ClearData
                Else
                    cboName.Text = stProjectName
                    If inEstimateID <> 999 Then
                        cboEstimate.Text = inEstimateID
                    Else
                        cboEstimate.Text = "Actual"
                    End If
                    Exit Sub
                End If
            'If no changes have been made that need to be saved, clear the form
            Else
                Call ClearData
            End If
        End If
    End If
End If

End Sub


Private Sub cboName_GotFocus()
'Increaes the width of the combo box to allow longer names to be viewed
cboName.Width = 3000
End Sub

Private Sub cboName_LostFocus()
Dim inResponse As Integer   'User response from message box
Dim inActualFLAG As Integer 'FLAG if estimate is "Actual" costs

inActualFLAG = 0
'Reset to normal width
cboName.Width = 1155

'If changes have been made that need to be saved, ...
If cmdSaveData.Enabled = True And cboName.Text <> stProjectName Then
    inResponse = ChangesMsg
    If inResponse = vbNo Then
        'Clear the form
        Call ClearData
    ElseIf inResponse = vbYes Then
        'Save the data and clear the form
        cmdSaveData_Click
        Call ClearData
    Else 'Cancel
        'Reset the value to the previous project ID
        cboName.Text = stProjectName
        Exit Sub
    End If
'If no changes have been made that need to be saved
    'and a different project ID has been selected, ...
ElseIf cboName.Text <> stProjectName Then
    'If project and estimate info are shown on Estimate Score Sheet form, ...
    If txtProject(0).Enabled = True Then
        Call ClearData
    End If
'If the project ID has not changed, exit the subroutine
Else
    Exit Sub
End If

'If an alpha-numeric value appears in the <Project ID> box
```

```
If cboName.Text >= "A" Then
    stProjectName = cboName.Text
    'Query the database to get the PROJECT_ID value for the selected project
    stSQL = "SELECT * FROM Project " _
        & " WHERE Project_Name = '" & cboName.Text & "'"
    Set rsProject = dbES.OpenRecordset(stSQL, dbOpenDynaset)

inRCount = rsProject.RecordCount

'If the project was found in the database, ...
If inRCount > 0 Then
    stProjectID = rsProject("project_id")
'If the project was not found, create it as a new project
Else
    rsProject.AddNew
    rsProject!Project_Name = cboName.Text
    rsProject.Update
    rsProject.MoveLast
    stProjectID = rsProject!Project_ID
End If

'Query the database to find the estimates that have been stored for the selected proj
ect
stSQL = "SELECT DISTINCTROW Estimate.Project_ID, Estimate.Estimate_ID, " & _
    " Project.Completed_Project " & _
    " FROM (Project INNER JOIN Estimate ON Project.Project_ID = " & _
    " Estimate.Project_ID) " & _
    " WHERE ((Estimate.Project_ID=" & stProjectID & "));"

    Set rsEstimateIDs = dbES.OpenRecordset(stSQL, dbOpenDynaset)

inNumEstimates = 0      'Counter for # of estimates that have been stored for the pro
ject
inRCount = rsEstimateIDs.RecordCount

'If no estimates have been stored, just add "New Estimate" to the <Estimate ID> combo
 box
If inRCount = 0 Then
    cboEstimate.Clear
    cboEstimate.AddItem "New Estimate"
    cboEstimate.Text = "New Estimate"
'If previous estimates have been stored, add their #'s to the <Estimate ID> combo box
Else
    rsEstimateIDs.MoveFirst
    cboEstimate.Clear
    stEstimateID = rsEstimateIDs("estimate_id")
    inEstimateID = Val(stEstimateID)
    If rsEstimateIDs("Completed_Project") = True Then
        inActualFLAG = 1
    End If
    cboEstimate.AddItem rsEstimateIDs("estimate_id")
    cboEstimate.Text = rsEstimateIDs("estimate_id")
    If inEstimateID > inNumEstimates And inEstimateID < 999 Then
        inNumEstimates = inEstimateID
    End If

    rsEstimateIDs.MoveNext
    While rsEstimateIDs.EOF <> True
            cboEstimate.AddItem rsEstimateIDs("estimate_id")
            inEstimateID = rsEstimateIDs("estimate_id")
            If inEstimateID > inNumEstimates And inEstimateID < 999 Then
                inNumEstimates = inEstimateID
            End If
            rsEstimateIDs.MoveNext
```

```
    Wend
    If inActualFLAG = 1 Then
        cboEstimate.AddItem "Actual"
    End If
    cboEstimate.AddItem "New Estimate"
End If


End If


End Sub

Private Sub chkExtenuating_Click()
    'Disable command button to signify that no changes have been made
    cmdSaveData.Enabled = True

End Sub

Private Sub cmdDelete_Click()
Dim rsDelete As Recordset   'Estimate to be deleted
Dim rsProject As Recordset  'Project from which estimate is to be deleted

'If <Project ID> box is empty, display message
If cboName.Text = "" Or cboEstimate.Text = "" Then
    stMSG = "You must type or select the project identifier from the <Project ID> box
."
    inButtons = vbOKOnly + vbApplicationModal
    inResponse = MsgBox(stMSG, inButtons, "Project ID?")
    Exit Sub
End If

'If estimate is "Actual" costs, ...
If cboEstimate.Text <> "Actual" Then
    stSQL = "SELECT Estimate.* " & _
        " FROM (Project INNER JOIN Estimate ON Project.Project_ID = " & _
        " Estimate.Project_ID) " & _
        " WHERE ((Project.Project_Name = '" & cboName.Text & "') AND " & _
        " (Estimate.Estimate_ID = " & cboEstimate.Text & "));"
    Set rsDelete = dbES.OpenRecordset(stSQL, dbOpenDynaset)
'If estimate is NOT "Actual" costs, ...
Else
    stSQL = "SELECT Completed_Project.* " & _
        " FROM (Project INNER JOIN Completed_Project ON Project.Project_ID = " & _
        " Completed_Project.Project_ID) " & _
        " WHERE (Project.Project_Name = '" & cboName.Text & "');"
    Set rsDelete = dbES.OpenRecordset(stSQL, dbOpenDynaset)
    stSQL = "SELECT Project.Completed_Project " & _
        " FROM Project WHERE (Project.Project_Name = '" & cboName.Text & "');"
    Set rsProject = dbES.OpenRecordset(stSQL, dbOpenDynaset)
End If


    'If a match is found, ...
    If Not rsDelete.NoMatch Then
        stMSG = "Are you sure you want to delete Estimate #" & _
            cboEstimate.Text & " of Project '" & cboName.Text & "?"
        inButtons = vbYesNoCancel + vbQuestion + vbDefaultButton2 + vbApplicationModa
l
        inResponse = MsgBox(stMSG, inButtons, "Delete Estimate Score?")
        If inResponse = vbCancel Then
            Exit Sub
        ElseIf inResponse = vbYes Then
```

```
            'Ask again, just to make sure!
            stMSG = "Are you sure you want to continue?  Deletion cannot be undone!"
            inButtons = vbYesNoCancel + vbQuestion + vbDefaultButton2 + vbApplication
Modal
            inResponse = MsgBox(stMSG, inButtons, "Delete Estimate Score?")
            If inResponse = vbCancel Then
                Exit Sub
            ElseIf inResponse = vbYes Then
                cmdSaveData.Enabled = False
                If rsDelete.RecordCount > 0 Then
                    rsDelete.Delete
                End If
                If cboEstimate.Text = "Actual" Then
                    rsProject.Edit
                    rsProject!Completed_Project = False
                    rsProject.Update
                End If
                stProjectName = ""
                Call cboName_LostFocus
                Call cboEstimate_LostFocus
            End If
        End If
    End If
End Sub


Private Sub cboSub_Change()
    'Enable command button to signify that changes have been made
    cmdSaveData.Enabled = True

End Sub

Private Sub cboSub_LostFocus()
If stProjectSub <> cboSub.Text Then
    'Enable command button to signify that changes have been made
    cmdSaveData.Enabled = True
End If
End Sub

Private Sub cboType_Change()
    'Enable command button to signify that changes have been made
    cmdSaveData.Enabled = True

End Sub

Private Sub cboType_LostFocus()
Dim stTemp As String
Dim inCount As Integer

If stProjectType <> cboType.Text Then
    'Enable command button to signify that changes have been made
    cmdSaveData.Enabled = True
    stTemp = cboSub.Text
    'Fill in <Project Sub-Type> combo box based on new project type
    Call FillCombo(cboSub, "ProjectCombo", cboType.Text, "")
    'If old value appears in new list, make that the current value also
    For inCount = 0 To cboSub.ListCount - 1
        If stTemp = cboSub.List(inCount) Then cboSub.ListIndex = inCount
    Next inCount
End If

stProjectType = cboType.Text
```

```
End Sub

Public Sub cmdExit_Click()

'If changes have been made that need to be saved, ...
If cmdSaveData.Enabled = True Then
    'Prompt the user to save the changes before continuing
    inResponse = ChangesMsg
    If inResponse = vbYes Then
        cmdSaveData_Click
    ElseIf inResponse = vbCancel Then
        Exit Sub
    End If
End If


    Unload frmScoreSheet

End Sub

Private Sub cmdFilter_Click()
'If changes have been made that need to be saved, ...
If cmdSaveData.Enabled = True Then
    'Prompt to see if the user wants to save changes before continuing
    inResponse = ChangesMsg
    If inResponse = vbYes Then
        cmdSaveData_Click
    ElseIf inResponse = vbCancel Then
        Exit Sub
    End If
End If



    frmScoreSheet.Hide
    frmFilter.Show
End Sub

Private Sub cmdGetData_Click()
Dim inResponse As Integer     'User response to message box
Dim stMSG As String           'Message for message box

'If changes have been made that need to be saved, ...
If cmdSaveData.Enabled = True Then
    'Prompt to see if the user wants to save changes before continuing
    inResponse = ChangesMsg
    If inResponse = vbNo Then
        Call ClearData
        Call FillData(cboEstimate.Text)
    ElseIf inResponse = vbYes Then
        cmdSaveData_Click
    Else
        Exit Sub
    End If
End If

'If a value appears in <Project ID> box, ...
If cboName.Text <> "" Then
    Call FillData(cboEstimate.Text)
    cmdSaveData.Enabled = False
'If no value appears in <Project ID> box, ...
Else
    stMSG = "You must type or select the project identifier from the <Project ID> box
."
```

```
    inButtons = vbOKOnly + vbApplicationModal
    inResponse = MsgBox(stMSG, inButtons, "Project ID?")
End If

End Sub

Private Sub cmdGraph_Click()


'If changes have been made that need to be saved, ...
If cmdSaveData.Enabled = True Then
    'Prompt to see if the user wants to save changes before continuing
    inResponse = ChangesMsg
    If inResponse = vbYes Then
        cmdSaveData_Click
    ElseIf inResponse = vbCancel Then
        Exit Sub
    End If
End If



    frmScoreSheet.Hide
    frmGraphs.Show
End Sub


Private Sub cmdSaveData_Click()
Dim stES As String
Dim inES As Integer
Dim inESopt As Integer
Dim inCount As Integer
Dim inCountJ, inCountK As Integer
Dim inResponse
Dim dbTotalCost As Double

inRCount = rsProject.RecordCount

If cboName.Text = "" Then Exit Sub

'If no contingency entered (left blank), check as "Extenuating"
If (StripCommas(txtEstimate(8).Text)) = (StripCommas(txtEstimate(9).Text)) Then
    chkExtenuating.Value = 1
    stMSG = "Base estimate (excluding contingency) must be greater than zero." & Chr(
13) & Chr(10) & _
        "Therefore <Extenuating Circum.> box has been checked."
    inButtons = vbOKOnly + vbInformation + vbApplicationModal
    inResponse = MsgBox(stMSG, inButtons, "<Extenuating Circum.> Checked")
End If

'If project has not been previously saved, add new project and save
If inRCount = 0 Then
    rsProject.AddNew
    rsProject!Project_Name = cboName.Text
    rsProject.Update
    rsProject.MoveLast
'If project has been previously saved, save the project and estimate info to the data
base
Else
    rsProject.Edit
    rsProject.Fields("company_name") = txtProject(1).Text
    rsProject.Fields("contact_person") = txtProject(2).Text
    rsProject.Fields("contact_number") = txtProject(3).Text
    rsProject.Fields("project_number") = txtProject(0).Text
```

```
    rsProject.Fields("project_type") = cboType.Text
    rsProject.Fields("project_sub_type") = cboSub.Text
    rsProject.Fields("project_disposition") = cbodispos.Text
    rsProject.Fields("owner_client") = txtProject(4).Text
    inRCount = rsEstimate.RecordCount
    'If estimate has not been previously saved, add new estimate and save
    If inRCount = 0 Then
        rsEstimate.AddNew
        rsEstimate!Project_ID = rsProject!Project_ID
        rsEstimate.Update
        rsEstimate.MoveLast
    End If

    rsEstimate.Edit

    'If estimate is not actual, save the estimate info to the estimate table
    If inEstimateID <> 999 Then 'if not actual
        rsEstimate.Fields("estimate_id") = inEstimateID
        rsEstimate.Fields("estimate_description") = txtEstimate(0).Text
        If txtEstimate(1).Text <> "" Then
            rsEstimate.Fields("estimate_date") = txtEstimate(1).Text
        End If
        rsEstimate.Fields("chief_estimator") = txtEstimate(2).Text
        If chkExtenuating.Value = 1 Then
            rsEstimate.Fields("Extenuating") = -1
        Else
            rsEstimate.Fields("Extenuating") = 0
        End If
        rsEstimate.Fields("Estimated_Engineering_Design") = (StripCommas(txtEstimate(
3).Text))
        rsEstimate.Fields("Estimated_Engineered_Equipment") = (StripCommas(txtEstimat
e(4).Text))
        rsEstimate.Fields("Estimated_Construction") = (StripCommas(txtEstimate(5).Tex
t))
        rsEstimate.Fields("Estimated_Other_Costs") = (StripCommas(txtEstimate(6).Text
))
        rsEstimate.Fields("Estimated_Owner_Costs") = (StripCommas(txtEstimate(7).Text
))
        rsEstimate.Fields("contingency") = (StripCommas(txtEstimate(8).Text))
        rsEstimate.Fields("Estimated_Total") = (StripCommas(txtEstimate(9).Text))
        rsEstimate.Fields("Business_Unit_Study") = StripCommas(txtEstimate(10).Text)
        rsEstimate.Fields("Preliminary_Engineering") = StripCommas(txtEstimate(11).Te
xt)
        rsEstimate.Fields("Detailed_Engineering") = StripCommas(txtEstimate(12).Text)
        rsEstimate.Fields("Procurement") = StripCommas(txtEstimate(13).Text)
        rsEstimate.Fields("Construction") = StripCommas(txtEstimate(14).Text)
        rsEstimate.Fields("Estimated_Other_Costs_Description") = txtEstimate(15).Text
        rsEstimate.Fields("Estimated_Bulk_Materials") = (StripCommas(txtEstimate(16).
Text))
        rsEstimate.Fields("Estimate_Comments") = txtEstimate(17).Text
        For inCount = 1 To 4
            For inCountJ = 1 To inDivCount(inCount)
                inES = 100 * inCount + inCountJ
                stES = "ES_" & CStr(inCount) & "_" & CStr(inCountJ)
                For inCountK = 1 To 5
                    inESopt = inES * 10 + inCountK
                    If optERI(inESopt).Value = True Then
                         rsEstimate.Fields(stES) = inCountK
                    End If
                Next inCountK
            Next inCountJ
        Next inCount
        stMSG = "Data for Project " & "'" & stProjectName & " Estimate #" & _
            stEstimateID & "' has been successfully saved!"
```

```
    'If estimate is actual, save the estimate info to the completed_projects table
    Else 'actual costs
        If txtEstimate(1).Text <> "" Then
            rsEstimate.Fields("Actual_Completion") = txtEstimate(1).Text
        End If
        rsEstimate.Fields("Actual_Engineering_Design") = (StripCommas(txtEstimate(3).
Text))
        rsEstimate.Fields("Actual_Engineered_Equipment") = (StripCommas(txtEstimate(4
).Text))
        rsEstimate.Fields("Actual_Construction") = (StripCommas(txtEstimate(5).Text))
        rsEstimate.Fields("Actual_Other_Costs") = (StripCommas(txtEstimate(6).Text))
        rsEstimate.Fields("Actual_Owner_Costs") = (StripCommas(txtEstimate(7).Text))
        rsEstimate.Fields("Actual_Total") = (StripCommas(txtEstimate(9).Text))
        rsEstimate.Fields("Actual_Other_Costs_Description") = txtEstimate(15).Text
        rsEstimate.Fields("Actual_Bulk_Materials") = (StripCommas(txtEstimate(16).Tex
t))
        rsEstimate.Fields("Actual_Comments") = txtEstimate(17).Text
        rsProject.Fields("Completed_Project") = True
        stMSG = "Data for Project " & "'" & stProjectName & _
            " Actual Costs' has been successfully saved!"
    End If

    rsProject.Update
    rsEstimate.Update
    cmdSaveData.Enabled = False
    inButtons = vbOKOnly + vbInformation + vbApplicationModal
    inResponse = MsgBox(stMSG, inButtons, "Save Data")

    'Check to make sure the individual cost boxes sum to the <Total> cost box
        'and, if not, display a warning message
    dbTotalCost = 0
    For inCount = 3 To 8
        dbTotalCost = dbTotalCost + Val(StripCommas(txtEstimate(inCount).Text))
    Next inCount
    dbTotalCost = dbTotalCost + Val(StripCommas(txtEstimate(16).Text))

    If dbTotalCost <> Val(StripCommas(txtEstimate(9).Text)) Then
        stMSG = "Individual cost categories do not add up to 'Total Project Cost'!  I
ndividual categories add up to " & AddCommas(CStr(dbTotalCost)) & "."
        inButtons = vbOKOnly + vbInformation + vbApplicationModal
        inResponse = MsgBox(stMSG, inButtons, "Inconsistent Cost Data")
    End If
End If
End Sub

Private Sub Form_Load()
'*** Code added by HelpWriter ***
    SetAppHelp Me.hWnd
'***********************************
    'Center the form on the screen
    frmScoreSheet.Top = (Screen.Height - frmScoreSheet.Height) / 2
    frmScoreSheet.Left = (Screen.Width - frmScoreSheet.Width) / 2
    Call ClearData
    cboName.Text = "       "
End Sub

Private Sub Form_Unload(Cancel As Integer)
'*** Code added by HelpWriter ***
    QuitHelp
'***********************************

    Dim inUserResponse As Integer   'Response from user
    Const conBtns As Integer = vbYesNo + vbExclamation + vbDefaultButton1 + vbApplica
tionModal
```

```
    'Prompt to make sure the user truly wants to exit
    inUserResponse = MsgBox("Do you want to exit?", conBtns, "Estimate Score Program"
)
    If inUserResponse = vbYes Then
        End
    Else
        Cancel = 1
    End If

End Sub

Private Sub fraERI_MouseMove(Index As Integer, Button As Integer, Shift As Integer, X
 As Single, Y As Single)
'Hide the ToolTips when the mouse moves away from the object
frmToolTip.Visible = False
'Stop the timer
Timer1.Enabled = False

End Sub

Private Sub lblERI_MouseMove(Index As Integer, Button As Integer, Shift As Integer, X
 As Single, Y As Single)
'Calculate the proper ToolTip placement
sgToolTop = frmScoreSheet.Top + lblERI(Index).Top + lblERI(Index).Height * 2.75
sgToolLeft = frmScoreSheet.Left + lblERI(Index).Left
'Get the ToolTip info from the .Tag property of the object
stTip = lblERI(Index).Tag
'Start the timer
Timer1.Enabled = True

End Sub

Private Sub optERI_Click(Index As Integer)
'Do not allow the user to access this with the <Tab> key when the division tabs are d
isabled
If tabInput.TabEnabled(1) = True Then
    txtERI(Int(Index / 10)).Text = Val(optERI(Index).Tag)
    'Enable the command button to signify that changes have been made that need to be
 saved
    cmdSaveData.Enabled = True
End If
End Sub

Private Sub optERI_MouseMove(Index As Integer, Button As Integer, Shift As Integer, X
 As Single, Y As Single)
'Calculate the location for the ToolTip
sgToolTop = frmScoreSheet.Top + fraERI(Int(Index / 10)).Top + fraERI(Int(Index / 10))
.Height * 2.25
sgToolLeft = frmScoreSheet.Left + fraERI(Int(Index / 10)).Left + optERI(Index).Left
'Get the ToolTip from the object's .Tag property
stTip = Mid(optERI(Index).Tag, 12)
'Start the timer
Timer1.Enabled = True

End Sub

Private Sub tabInput_MouseMove(Button As Integer, Shift As Integer, X As Single, Y As
 Single)
```

```
'Stop the timer
Timer1.Enabled = False
'Hide the ToolTip
frmToolTip.Visible = False

End Sub


Private Sub Timer1_Timer()
'Show the ToolTip after the timer's time is reached
Call ShowToolTip

End Sub


Private Sub txtDivScore_Change(Index As Integer)
    Dim inCount As Integer  'Counter

    sgDivScore(0) = 0
    sgDivPossible(0) = 0
    'Step through the 4 divisions and total the scores and worst possible score
    For inCount = 1 To 4
        sgDivScore(inCount) = Val(txtDivScore(inCount).Text)
        sgDivPossible(inCount) = Val(txtDivScore(inCount).Tag)
        sgDivScore(0) = sgDivScore(0) + sgDivScore(inCount)
        sgDivPossible(0) = sgDivPossible(0) + sgDivPossible(inCount)
    Next inCount
    If sgDivScore(0) >= 100 Then
        txtEScore.Text = Format(sgDivScore(0), "      000.0")
    ElseIf sgDivScore(0) >= 10 Then
        txtEScore.Text = Format(sgDivScore(0), "       00.0")
    Else
        txtEScore.Text = Format(sgDivScore(0), "       0.0")
    End If

End Sub

Private Sub txtERI_Change(Index As Integer)
    Dim inCount As Integer      'Counter
    Dim inES As Integer         'Element # = ddee (d=div; e=element)
    Dim inDivision As Integer   'Division #

    'Format the text box to be right-justified
    If Val(txtERI(Index).Text) >= 0 Then
        If Val(txtERI(Index).Text) < 10 Then
            txtERI(Index).Text = Format(Val(txtERI(Index).Text), "  0.0")
        ElseIf Val(txtERI(Index).Text) < 100 Then
            txtERI(Index).Text = Format(Val(txtERI(Index).Text), " 00.0")
        Else
            txtERI(Index).Text = Format(Val(txtERI(Index).Text), " 000")
        End If
    'If the rating is zero, show "N/A" in the score box
    Else
        txtERI(Index).Text = " N/A"
    End If

    inDivision = Int(Index / 100)
    sgDivScore(inDivision) = 0
    sgDivPossible(inDivision) = 0
    'Recalculate the total for this division
    For inCount = 1 To inDivCount(inDivision)
        inES = (inDivision) * 100 + inCount
'        If optERI(inES * 10).Value = False Then
            sgDivPossible(inDivision) = sgDivPossible(inDivision) + Val(optERI(inES *
```

```
 10 + 5).Tag)
            sgDivScore(inDivision) = sgDivScore(inDivision) + Val(txtERI(inES))
'         End If
    Next inCount
    txtDivScore(inDivision).Tag = CStr(sgDivPossible(inDivision))
    If sgDivScore(inDivision) >= 10 Then
        txtDivScore(inDivision).Text = Format(sgDivScore(inDivision), "          00.0
")
    Else
        txtDivScore(inDivision).Text = Format(sgDivScore(inDivision), "           0.0
")
    End If
End Sub


Private Sub txtEScore_Change()
If Val(txtEScore.Text) >= 100 Then
    frmGraphs.txtES.Text = Format(Val(txtEScore.Text), "  000.0")
ElseIf Val(txtEScore.Text) >= 10 Then
    frmGraphs.txtES.Text = Format(Val(txtEScore.Text), "   00.0")
Else
    frmGraphs.txtES.Text = Format(Val(txtEScore.Text), "    0.0")
End If

End Sub

Private Sub txtEstimate_Change(Index As Integer)
    Dim inCount As Integer
    Dim dbTotal As Double
    Dim stAdd As String

    stAdd = ""
    dbTotal = 0
    'Enable the command button to signify that changes have occurred that need to be
saved
    cmdSaveData.Enabled = True

    'Reformat the cost boxes
    Select Case Index
        'If the box is an estimated cost box
        Case 3, 4, 5, 6, 7, 8, 16
            For inCount = 3 To 8
                dbTotal = dbTotal + Val(StripCommas(txtEstimate(inCount).Text))
            Next inCount
            txtEstimate(9).Text = AddCommas(dbTotal + Val(StripCommas(txtEstimate(16)
.Text)))
        For inCount = Len(txtEstimate(9).Text) To 17
            stAdd = " " & stAdd
        Next inCount
        txtEstimate(9).Text = stAdd & txtEstimate(9).Text
    End Select
End Sub


Private Sub txtEstimate_LostFocus(Index As Integer)
Dim inCount As Integer
Dim stAdd As String

stAdd = ""

'Reformat the text box
Select Case Index
    'If it's the date box
    Case 1
```

```
        txtEstimate(Index).Text = Format(txtEstimate(Index).Text, "mm/dd/yy")
    'If it's a cost box
    Case 3, 4, 5, 6, 7, 8, 9, 16
        If StripCommas(txtEstimate(Index).Text) = "" Then
            txtEstimate(Index) = ""
        ElseIf Val(txtEstimate(Index).Text) = 0 Then
            txtEstimate(Index) = "                0"
        ElseIf Val(txtEstimate(Index).Text) > 0 Then
            txtEstimate(Index).Text = AddCommas(txtEstimate(Index).Text)
            For inCount = Len(txtEstimate(Index).Text) To 17
                stAdd = " " & stAdd
            Next inCount
            txtEstimate(Index).Text = stAdd & txtEstimate(Index).Text
        End If
        'If it's the contingency box
        If Index = 8 Then
            If Val(StripCommas(txtEstimate(8).Text)) <> 0 And Val(StripCommas(txtEsti
mate(9).Text)) <> 0 Then
                txtPercentContingency = Format(100 * (StripCommas(txtEstimate(8).Text
) / _
                    (StripCommas(txtEstimate(9).Text) - StripCommas(txtEstimate(8).Te
xt))), "  0.0")
            ElseIf InStr(txtEstimate(8).Text, "0") Then
                txtPercentContingency = "  0.0"
            Else
                txtPercentContingency = ""
            End If
        End If
    'If it's a %-complete box
    Case 10, 11, 12, 13, 14
        If StripCommas(txtEstimate(Index).Text) = "" Then
            txtEstimate(Index).Text = ""
        ElseIf Val(txtEstimate(Index).Text) <= 0 Then
            txtEstimate(Index).Text = "0"
        ElseIf Val(txtEstimate(Index).Text) >= 100 Then
            txtEstimate(Index).Text = "100"
        End If
        txtEstimate(Index).Text = StripCommas(txtEstimate(Index).Text)
        For inCount = Len(txtEstimate(Index).Text) To 4
            stAdd = " " & stAdd
        Next inCount
        txtEstimate(Index).Text = stAdd & txtEstimate(Index).Text
End Select

End Sub


Private Sub txtPercentContingency_LostFocus()

'If the box is blank, leave the <Contingency> box blank
If StripCommas(txtPercentContingency.Text) = "" Then
    txtEstimate(8).Text = ""
'If the box is not blank, calculate the proper contingency
    'and put it in the <Contingency> box
Else
    txtPercentContingency.Text = Format(Val(txtPercentContingency.Text), "  0.0")
    If Val(StripCommas(txtEstimate(8).Text)) <> 0 And Val(StripCommas(txtEstimate(9).
Text)) <> 0 Then
        txtEstimate(8).Text = (StripCommas(txtEstimate(9).Text) - StripCommas(txtEsti
mate(8).Text)) _
            * Val(txtPercentContingency.Text) / 100
    ElseIf Val(StripCommas(txtEstimate(8).Text)) = 0 Then
        txtEstimate(8).Text = StripCommas(txtEstimate(9).Text) * Val(txtPercentContin
gency.Text) / 100
```

```
    ElseIf Val(StripCommas(txtEstimate(9).Text)) = 0 Then
        txtEstimate(8).Text = ""
    End If
End If

'Call LostFocus to reformat the contingency box
txtEstimate_LostFocus (8)

End Sub


Private Sub txtProject_Change(Index As Integer)
    'Enable the command button to signify that changes have occurred that need to be
saved
    cmdSaveData.Enabled = True

End Sub


Private Sub txtProject_GotFocus(Index As Integer)
'Increase width to view international #s
If Index = 3 Then txtProject(Index).Width = 3000

End Sub


Private Sub txtProject_LostFocus(Index As Integer)
'Reduce to normal width
If Index = 3 Then txtProject(Index).Width = 1150

End Sub
```

```
Option Explicit

Private Sub FillLine(Index As Integer)
Dim stSQL As String
Dim rsStats As Recordset

stStatsOperator = cboOperator.Text
stSQL = "SELECT * FROM StatsOperator " _
    & " WHERE (Operator = '" & stStatsOperator & "')"
Set rsStats = dbES.OpenRecordset(stSQL, dbOpenDynaset)
stStatsOperator = rsStats!Operator_Use

stFirst = cboFirst.Text
stSecond = cboSecond.Text
lblExpression(Index).Caption = stFirst & stStatsOperator & stSecond

End Sub

Private Sub cboFirst_Change()
cmdCalcStats.Enabled = True

End Sub

Private Sub cboFirst_Click()
cmdCalcStats.Enabled = True


End Sub

Private Sub cboFirst_LostFocus()
FillLine (Val(cboLine.Text) - 1)
End Sub

Private Sub cboLine_Change()
cmdCalcStats.Enabled = True
Call cboLine_LostFocus
End Sub

Private Sub cboLine_LostFocus()
Dim rsStats As Recordset
Dim stSQL As String


Call Parse(lblExpression(Val(cboLine.Text) - 1).Caption)

If stStatsOperator <> "" Then
    stSQL = "SELECT * FROM StatsOperator " _
        & " WHERE (Operator_Use = '" & stStatsOperator & "')"
    Set rsStats = dbES.OpenRecordset(stSQL, dbOpenDynaset)
    cboOperator.Text = rsStats!Operator
End If

If stFirst <> "" Then
    cboFirst.Text = stFirst
End If
If stSecond <> "" Then
    cboSecond.Text = stSecond
End If

End Sub
```

```
Private Sub cboOperator_Change()
cmdCalcStats.Enabled = True

End Sub

Private Sub cboOperator_Click()
cmdCalcStats.Enabled = True


End Sub

Private Sub cboOperator_LostFocus()
FillLine (Val(cboLine.Text) - 1)

End Sub

Private Sub cboSecond_Change()
cmdCalcStats.Enabled = True

End Sub

Private Sub cboSecond_Click()
cmdCalcStats.Enabled = True


End Sub

Private Sub cboSecond_LostFocus()
FillLine (Val(cboLine.Text) - 1)

End Sub

Private Sub cmdExit_Click()
Call frmScoreSheet.cmdExit_Click
End Sub




Private Sub cmdCalcStats_Click()
Dim inCount As Integer
Dim rsStats As Recordset
Dim stSQL As String

For inCount = 0 To 14
    Call Parse(lblExpression(inCount).Caption)
    If stStatsOperator <> "" Then
        Call CalcStats(inCount)
    End If
Next inCount

stStatsOperator = cboOperator.Text
stSQL = "SELECT * FROM StatsOperator " _
    & " WHERE (Operator = '" & stStatsOperator & "')"
Set rsStats = dbES.OpenRecordset(stSQL, dbOpenDynaset)
stStatsOperator = rsStats!Operator_Use

stFirst = cboFirst.Text
stSecond = cboSecond.Text
Call CalcStats(Val(cboLine.Text) - 1)
cmdCalcStats.Enabled = False
```

```
End Sub

Private Sub cmdClearAll_Click()
Dim inCount As Integer

cboLine.Text = 1
For inCount = 0 To 14
    lblExpression(inCount).Caption = ""
    lblN(inCount).Caption = ""
    lblMin(inCount).Caption = ""
    lblMax(inCount).Caption = ""
    lblMean(inCount).Caption = ""
    lblStdDev(inCount).Caption = ""
Next inCount
cmdCalcStats.Enabled = True

End Sub

Private Sub cmdClearLine_Click()


lblExpression(Val(cboLine.Text) - 1).Caption = ""
lblN(Val(cboLine.Text) - 1).Caption = ""
lblMin(Val(cboLine.Text) - 1).Caption = ""
lblMax(Val(cboLine.Text) - 1).Caption = ""
lblMean(Val(cboLine.Text) - 1).Caption = ""
lblStdDev(Val(cboLine.Text) - 1).Caption = ""
cmdCalcStats.Enabled = True
cboLine.Text = 1
End Sub

Private Sub cmdFilter_Click()
    frmStats.Hide
    frmFilter.Show
End Sub

Private Sub Form_Activate()
cmdCalcStats.Enabled = True
cmdCalcStats_Click
End Sub

Private Sub Form_Load()
    Call FillCombo(cboFirst, "StatsField", "Field", "")
    Call FillCombo(cboOperator, "StatsOperator", "Operator", "")
    Call FillCombo(cboSecond, "StatsField", "Field", "")
    frmStats.Top = (Screen.Height - frmStats.Height) / 2
    frmStats.Left = (Screen.Width - frmStats.Width) / 2

End Sub




Private Sub CalcStats(Index As Integer)
Dim vrVariant As Variant
Dim dbFirst, dbSecond As Double
Dim dbMin, dbMax, dbSD, dbMean, dbSumZ, dbSumZZ As Double
Dim dbZbar, dbZ(300), dbSumZMinusZbar2 As Double
```

```
Dim inExprCount, inCount As Integer
Dim stSQL As String
Dim stFirstUse, stSecondUse As String
Dim rsStats As Recordset


stSQL = "SELECT * FROM StatsField " _
    & " WHERE (Field = '" & stFirst & "')"
Set rsStats = dbES.OpenRecordset(stSQL, dbOpenDynaset)
stFirstUse = rsStats!Field_Use

stSQL = "SELECT * FROM StatsField " _
    & " WHERE (Field = '" & stSecond & "')"
Set rsStats = dbES.OpenRecordset(stSQL, dbOpenDynaset)
stSecondUse = rsStats!Field_Use


inRCount = rsFilter.RecordCount

If inRCount <> 0 Then
    rsFilter.MoveFirst
    vrVariant = rsFilter(stFirstUse)
    If vrVariant <> "" Then
        dbFirst = vrVariant
    Else
        dbFirst = 0
    End If
    vrVariant = rsFilter(stSecondUse)
    If vrVariant <> "" Then
        dbSecond = vrVariant
    Else
        dbSecond = 0
    End If
End If
inExprCount = 0
dbSumZ = 0
dbSumZZ = 0
If stFirst = "One" Then dbFirst = 1
If stFirst = "One Hundred" Then dbFirst = 100
If stFirst = "One Thousand" Then dbFirst = 1000
If stFirst = "One Million" Then dbFirst = 1000000
If stSecond = "One" Then dbSecond = 1
If stSecond = "One Thousand" Then dbSecond = 1000
If stSecond = "One Hundred" Then dbSecond = 100
If stSecond = "One Million" Then dbSecond = 1000000
If dbFirst <> 0 And dbSecond <> 0 Then
    If stStatsOperator = "/" Then
        dbZ(inExprCount) = dbFirst / dbSecond
    ElseIf stStatsOperator = "*" Then
        dbZ(inExprCount) = dbFirst * dbSecond
    ElseIf stStatsOperator = "+" Then
        dbZ(inExprCount) = dbFirst + dbSecond
    ElseIf stStatsOperator = "-" Then
        dbZ(inExprCount) = dbFirst - dbSecond
    End If
    dbSumZ = dbSumZ + dbZ(inExprCount)
    dbSumZZ = dbSumZZ + dbZ(inExprCount) ^ 2
    inExprCount = inExprCount + 1
End If
If inRCount <> 0 Then
    rsFilter.MoveNext
End If
While rsFilter.EOF <> True
    vrVariant = rsFilter(stFirstUse)
```

```
    If vrVariant <> "" Then
        dbFirst = vrVariant
    Else
        dbFirst = 0
    End If
    vrVariant = rsFilter(stSecondUse)
    If vrVariant <> "" Then
        dbSecond = vrVariant
    Else
        dbSecond = 0
    End If
    If stFirst = "One" Then dbFirst = 1
    If stFirst = "One Hundred" Then dbFirst = 100
    If stFirst = "One Thousand" Then dbFirst = 1000
    If stFirst = "One Million" Then dbFirst = 1000000
    If stSecond = "One" Then dbSecond = 1
    If stSecond = "One Hundred" Then stSecond = 100
    If stSecond = "One Thousand" Then dbSecond = 1000
    If stSecond = "One Million" Then dbSecond = 1000000
    If dbFirst <> 0 And dbSecond <> 0 Then
        If stStatsOperator = "/" Then
            dbZ(inExprCount) = dbFirst / dbSecond
        ElseIf stStatsOperator = "*" Then
            dbZ(inExprCount) = dbFirst * dbSecond
        ElseIf stStatsOperator = "+" Then
            dbZ(inExprCount) = dbFirst + dbSecond
        ElseIf stStatsOperator = "-" Then
            dbZ(inExprCount) = dbFirst - dbSecond
        End If
        dbSumZ = dbSumZ + dbZ(inExprCount)
        dbSumZZ = dbSumZZ + dbZ(inExprCount) ^ 2
        inExprCount = inExprCount + 1
    End If
    rsFilter.MoveNext
Wend

If inExprCount > 0 Then
    dbZbar = dbSumZ / inExprCount
    dbSumZMinusZbar2 = 0
    dbMin = dbZ(0)
    dbMax = dbZ(0)
    For inCount = 0 To inExprCount - 1
        dbSumZMinusZbar2 = dbSumZMinusZbar2 + (dbZ(inCount) - dbZbar) ^ 2
        If dbZ(inCount) > dbMax Then dbMax = dbZ(inCount)
        If dbZ(inCount) < dbMin Then dbMin = dbZ(inCount)
    Next inCount
    If inExprCount > 2 Then dbSD = dbSumZMinusZbar2 / (inExprCount - 2)
    lblMin(Index).Caption = LineFormat(dbMin)
    lblMax(Index).Caption = LineFormat(dbMax)
    lblMean(Index).Caption = LineFormat(dbZbar)
    lblStdDev(Index).Caption = LineFormat(dbSD)
Else
    lblMin(Index).Caption = "N/A"
    lblMax(Index).Caption = "N/A"
    lblMean(Index).Caption = "N/A"
    lblStdDev(Index).Caption = "N/A"
End If
lblExpression(Index).Caption = stFirst & stStatsOperator & stSecond
lblN(Index).Caption = CStr(inExprCount)

End Sub


Private Sub Form_Unload(Cancel As Integer)
```

```
'*** Code added by HelpWriter ***
    QuitHelp
'***********************************

    Dim inUserResponse As Integer   'Response from user
    Const conBtns As Integer = vbYesNo + vbExclamation + vbDefaultButton1 + vbApplica
tionModal

    'Prompt to make sure the user truly wants to exit
    inUserResponse = MsgBox("Do you want to exit?", conBtns, "Estimate Score Program"
)
    If inUserResponse = vbYes Then
        End
    Else
        Cancel = 1
    End If


End Sub

Private Sub lblExpression_Click(Index As Integer)
    cboFirst_LostFocus
    cboOperator_LostFocus
    cboSecond_LostFocus
    cboFirst.SetFocus
    cboLine.Text = Index + 1
    If lblExpression(Index).Caption = "" Then
        FillLine (Index)
    End If
End Sub

Private Sub lblMax_Click(Index As Integer)
    cboFirst_LostFocus
    cboOperator_LostFocus
    cboSecond_LostFocus
    cboFirst.SetFocus
    cboLine.Text = Index + 1
    If lblExpression(Index).Caption = "" Then
        FillLine (Index)
    End If

End Sub

Private Sub lblMean_Click(Index As Integer)
    cboFirst_LostFocus
    cboOperator_LostFocus
    cboSecond_LostFocus
    cboFirst.SetFocus
    cboLine.Text = Index + 1
    If lblExpression(Index).Caption = "" Then
        FillLine (Index)
    End If

End Sub

Private Sub lblMin_Click(Index As Integer)
    cboFirst_LostFocus
    cboOperator_LostFocus
    cboSecond_LostFocus
    cboFirst.SetFocus
    cboLine.Text = Index + 1
    If lblExpression(Index).Caption = "" Then
        FillLine (Index)
    End If
```

```
End Sub

Private Sub lblN_Click(Index As Integer)
    cboFirst_LostFocus
    cboOperator_LostFocus
    cboSecond_LostFocus
    cboFirst.SetFocus
    cboLine.Text = Index + 1
    If lblExpression(Index).Caption = "" Then
        FillLine (Index)
    End If

End Sub

Private Sub lblNumber_Click(Index As Integer)
    cboFirst_LostFocus
    cboOperator_LostFocus
    cboSecond_LostFocus
    cboFirst.SetFocus
    cboLine.Text = Index + 1
    If lblExpression(Index).Caption = "" Then
        FillLine (Index)
    End If

End Sub

Private Sub lblStdDev_Click(Index As Integer)
    cboFirst_LostFocus
    cboOperator_LostFocus
    cboSecond_LostFocus
    cboFirst.SetFocus
    cboLine.Text = Index + 1
    If lblExpression(Index).Caption = "" Then
        FillLine (Index)
    End If

End Sub


Private Sub Parse(stFull As String)

If InStr(stFull, "/") > 0 Then
    stStatsOperator = "/"
ElseIf InStr(stFull, "*") > 0 Then
    stStatsOperator = "*"
ElseIf InStr(stFull, "+") > 0 Then
    stStatsOperator = "+"
ElseIf InStr(stFull, "-") > 0 Then
    stStatsOperator = "-"
Else:
    stStatsOperator = ""
    stSecond = ""
    stFirst = ""
    Exit Sub
End If

stSecond = Mid(stFull, InStr(stFull, stStatsOperator) + 1)

stFirst = Mid(stFull, 1, InStr(stFull, stStatsOperator) - 1)

End Sub

Private Function LineFormat(ByVal dbValue As Double) As String
```

```
If Abs(dbValue) < 100000 Then
    LineFormat = Format(dbValue, "##,##0.000")
ElseIf Abs(dbValue) < 100000000 Then
    LineFormat = Format(dbValue, "##,###,##0")
Else
    LineFormat = Format(dbValue, "0.000 E+00")
End If
End Function
```

```
Option Explicit
'=====================================================================
'=====================================================================
'
'This source code contains the following routines:
'  o SetAppHelp() 'Called in the main Form_Load event to register your
'                 'program with WINHELP.EXE
'  o QuitHelp()     'Deregisters your program with WINHELP.EXE. Should
'                   'be called in your main Form_Unload event
'  o ShowHelpTopic(Topicnum) 'Brings up context sensitive help based on
'                   'any of the following CONTEXT IDs
'  o ShowContents  'Displays the startup topic
'  o HelpWindowSize(x,y,dx,dy) ' Position help window in a screen
'                              ' independent manner
'  o SearchHelp()  'Brings up the windows help KEYWORD SEARCH dialog box
'*********************************************************************
'
'=====================================================================
'List of Context IDs for <ESP>
'=====================================================================
Global Const Hlp_ESTIMATE_SCORE = 10     'Main Help Window
Global Const Hlp_STATISTICS_ = 30     'Main Help Window
Global Const Hlp_ESTIMATE_SCORE1 = 40     'Main Help Window
Global Const Hlp_FILTER_SELECTION = 50     'Main Help Window
Global Const Hlp_Project_Info = 60     'Main Help Window
Global Const Hlp_Division_1 = 70     'Main Help Window
Global Const Hlp_Division_2 = 80     'Main Help Window
Global Const Hlp_Division_3 = 90     'Main Help Window
Global Const Hlp_Division_4 = 100     'Main Help Window
Global Const Hlp_Estimate_Score2 = 110     'Main Help Window
Global Const Hlp_Estimate_Score3 = 120     'Main Help Window
Global Const Hlp_1x1x_ = 140    'Main Help Window
Global Const Hlp_1x2x_ = 150    'Main Help Window
Global Const Hlp_1x3x_ = 160    'Main Help Window
Global Const Hlp_1x4x_ = 170    'Main Help Window
Global Const Hlp_1x5x_ = 180    'Main Help Window
Global Const Hlp_1x6x_ = 190    'Main Help Window
Global Const Hlp_1x7x_ = 200    'Main Help Window
Global Const Hlp_1x8x_ = 210    'Main Help Window
Global Const Hlp_1x9x_ = 220    'Main Help Window
Global Const Hlp_2x1x_ = 240    'Main Help Window
Global Const Hlp_2x2x_ = 250    'Main Help Window
Global Const Hlp_2x3x_ = 260    'Main Help Window
Global Const Hlp_2x4x_ = 270    'Main Help Window
Global Const Hlp_2x5x_ = 280    'Main Help Window
Global Const Hlp_2x6x_ = 290    'Main Help Window
Global Const Hlp_2x7x_ = 300    'Main Help Window
Global Const Hlp_2x8x_ = 310    'Main Help Window
Global Const Hlp_2x9x_ = 320    'Main Help Window
Global Const Hlp_2x10x_ = 330    'Main Help Window
Global Const Hlp_2x11x_ = 340    'Main Help Window
Global Const Hlp_3x1x_ = 350    'Main Help Window
Global Const Hlp_3x2x_ = 360    'Main Help Window
Global Const Hlp_3x3x_ = 370    'Main Help Window
Global Const Hlp_3x4x_ = 380    'Main Help Window
Global Const Hlp_3x5x_ = 390    'Main Help Window
Global Const Hlp_3x6x_ = 400    'Main Help Window
Global Const Hlp_3x7x_ = 410    'Main Help Window
Global Const Hlp_3x8x_ = 420    'Main Help Window
Global Const Hlp_3x9x_ = 430    'Main Help Window
Global Const Hlp_3x10x_ = 440    'Main Help Window
Global Const Hlp_3x11x_ = 450    'Main Help Window
Global Const Hlp_3x12x_ = 460    'Main Help Window
Global Const Hlp_3x13x_ = 470    'Main Help Window
```

```
Global Const Hlp_3x14x_ = 480    'Main Help Window
Global Const Hlp_4x1x_ = 500    'Main Help Window
Global Const Hlp_4x2x_ = 510    'Main Help Window
Global Const Hlp_4x3x_ = 520    'Main Help Window
Global Const Hlp_4x4x_ = 530    'Main Help Window
Global Const Hlp_4x5x_ = 540    'Main Help Window
Global Const Hlp_4x6x_ = 550    'Main Help Window
Global Const Hlp_4x7x_ = 560    'Main Help Window
Global Const Hlp_4x8x_ = 570    'Main Help Window
Global Const Hlp_4x9x_ = 580    'Main Help Window
Global Const Hlp_4x10x_ = 590    'Main Help Window
Global Const Hlp_4x11x_ = 600    'Main Help Window
Global Const GLOS_Construction_Industry_Institute_xCIIx = 620
Global Const GLOS_CII_Research_Team_x131 = 630
Global Const GLOS_xRetrieve_ESx = 640
Global Const GLOS_xDelete_ESx = 650
Global Const GLOS_xSave_ESx = 660
Global Const GLOS_xEdit_Filterx = 670
Global Const GLOS_xView_Graphsx = 680
Global Const GLOS_xExitx = 690
Global Const GLOS_Division_1_Score = 700
Global Const GLOS_Division_2_Score = 710
Global Const GLOS_Division_3_Score = 720
Global Const GLOS_Division_4_Score = 730
Global Const GLOS_Raw_Score = 740
Global Const GLOS_Estimate_Score_text_box = 750
'======================================================================
'
'
'  Help engine section.

' Commands to pass WinHelp()
Global Const HELP_CONTEXT = &H1 '  Display topic in ulTopic
Global Const HELP_QUIT = &H2    '  Terminate help
Global Const HELP_FINDER = &HB  '  Display Contents tab
Global Const HELP_INDEX = &H3   '  Display index
Global Const HELP_HELPONHELP = &H4       '  Display help on using help
Global Const HELP_SETINDEX = &H5         '  Set the current Index for multi index help
Global Const HELP_KEY = &H101            '  Display topic for keyword in offabData
Global Const HELP_MULTIKEY = &H201
Global Const HELP_CONTENTS = &H3      ' Display Help for a particular topic
Global Const HELP_SETCONTENTS = &H5   ' Display Help contents topic
Global Const HELP_CONTEXTPOPUP = &H8  ' Display Help topic in popup window
Global Const HELP_FORCEFILE = &H9     ' Ensure correct Help file is displayed
Global Const HELP_COMMAND = &H102     ' Execute Help macro
Global Const HELP_PARTIALKEY = &H105  ' Display topic found in keyword list
Global Const HELP_SETWINPOS = &H203   ' Display and position Help window

#If Win32 Then
    Type HELPWININFO
      wStructSize As Long
      X As Long
      Y As Long
      dX As Long
      dY As Long
      wMax As Long
      rgChMember As String * 2
    End Type
    Declare Function WinHelp Lib "User32.dll" Alias "WinHelpA" (ByVal hWnd As Long, B
yVal lpHelpFile As String, ByVal wCommand As Long, ByVal dwData As Any) As Long
    Declare Function WinHelpByInfo Lib "User32.dll" Alias "WinHelpA" (ByVal hWnd As L
ong, ByVal lpHelpFile As String, ByVal wCommand As Long, dwData As HELPWININFO) As Lo
ng
    Declare Function WinHelpByStr Lib "User32.dll" Alias "WinHelpA" (ByVal hWnd As Lo
```

```
ng, ByVal lpHelpFile As String, ByVal wCommand As Long, ByVal dwData$) As Long
    Declare Function WinHelpByNum Lib "User32.dll" Alias "WinHelpA" (ByVal hWnd As Lo
ng, ByVal lpHelpFile As String, ByVal wCommand As Long, ByVal dwData&) As Long
    Dim m_hWndMainWindow As Long ' hWnd to tell WINHELP the helpfile owner

#Else
    Type HELPWININFO
        wStructSize As Integer
        X As Integer
        Y As Integer
        dX As Integer
        dY As Integer
        wMax As Integer
        rgChMember As String * 2
    End Type
    Declare Function WinHelp Lib "User" (ByVal hWnd As Integer, ByVal lpHelpFile As S
tring, ByVal wCommand As Integer, ByVal dwData As Any) As Integer
    Declare Function WinHelpByInfo Lib "User" Alias "WinHelp" (ByVal hWnd As Integer,
 ByVal lpHelpFile As String, ByVal wCommand As Integer, dwData As HELPWININFO) As Int
eger
    Declare Function WinHelpByStr Lib "User" Alias "WinHelp" (ByVal hWnd As Integer,
ByVal lpHelpFile As String, ByVal wCommand As Integer, ByVal dwData$) As Integer
    Declare Function WinHelpByNum Lib "User" Alias "WinHelp" (ByVal hWnd As Integer,
ByVal lpHelpFile As String, ByVal wCommand As Integer, ByVal dwData&) As Integer
    Dim m_hWndMainWindow As Integer ' hWnd to tell WINHELP the helpfile owner

#End If
Dim MainWindowInfo As HELPWININFO
Sub SetAppHelp(ByVal hWndMainWindow)
'======================================================================
'To use these subroutines to access WINHELP, you need to add
'at least this one subroutine call to your code
'     o  In the Form_Load event of your main Form enter:
'        Call SetAppHelp(Me.hWnd) 'To setup helpfile variables
'         (If you are not interested in keyword searching or context
'         sensitive help, this is the only call you need to make!)
'======================================================================
    m_hWndMainWindow = hWndMainWindow
    If Right$(Trim$(App.Path), 1) = "\" Then
        App.HelpFile = App.Path + "ESP.HLP"
    Else
        App.HelpFile = App.Path + "\ESP.HLP"
    End If
#If Win32 Then
    MainWindowInfo.wStructSize = 26
#Else
    MainWindowInfo.wStructSize = 14
#End If
    MainWindowInfo.X = 256
    MainWindowInfo.Y = 256
    MainWindowInfo.dX = 512
    MainWindowInfo.dY = 512
    MainWindowInfo.rgChMember = Chr$(0) + Chr$(0)
End Sub
Sub QuitHelp()
    Dim Result As Variant
    Result = WinHelp(m_hWndMainWindow, App.HelpFile, HELP_QUIT, Chr$(0) + Chr$(0) + C
hr$(0) + Chr$(0))
End Sub
Sub ShowHelpTopic(ByVal ContextID As Long)
'======================================================================
'  FOR CONTEXT SENSITIVE HELP IN RESPONSE TO A COMMAND BUTTON ...
'======================================================================
'     o   For 'Help button' controls, you can call:
```

```
'         Call ShowHelpTopic(<any Hlpxxx entry above>)
'====================================================================
'  TO ADD FORM LEVEL CONTEXT SENSITIVE HELP...
'====================================================================
'      o  For FORM level context sensetive help, you should set each
'         Me.HelpContext=<any Hlp_xxx entry above>
'
    Dim Result As Variant

    Result = WinHelpByNum(m_hWndMainWindow, App.HelpFile, HELP_CONTEXT, CLng(ContextI
D))

End Sub
Sub ShowHelpTopic2(ByVal ContextID As Long)
'====================================================================
'  DISPLAY CONTEXT SENSITIVE HELP IN WINDOW 2 ...
'====================================================================
'      o   For 'Help button' controls, you can call:
'          Call ShowHelpTopic2(<any Hlpxxx entry above>)
'
    Dim Result As Variant

    Result = WinHelpByNum(m_hWndMainWindow, App.HelpFile & ">HlpWnd02", HELP_CONTEXT,
 CLng(ContextID))

End Sub
Sub ShowHelpTopic3(ByVal ContextID As Long)
'====================================================================
'  DISPLAY CONTEXT SENSITIVE HELP IN WINDOW 3 ...
'====================================================================
'      o   For 'Help button' controls, you can call:
'          Call ShowHelpTopic3(<any Hlpxxx entry above>)
'
    Dim Result As Variant

    Result = WinHelpByNum(m_hWndMainWindow, App.HelpFile & ">HlpWnd03", HELP_CONTEXT,
 CLng(ContextID))

End Sub
Sub ShowGlossary()
    Dim Result As Variant

    Result = WinHelpByNum(m_hWndMainWindow, App.HelpFile, HELP_CONTEXT, CLng(64000))

End Sub
Sub ShowPopupHelp(ByVal ContextID As Long)
'====================================================================
'  FOR POPUP HELP IN RESPONSE TO A COMMAND BUTTON ...
'====================================================================
    Dim Result As Variant

    Result = WinHelpByNum(m_hWndMainWindow, App.HelpFile, HELP_CONTEXTPOPUP, CLng(Con
textID))

End Sub
Sub DoHelpMacro(ByVal MacroString As String)
'====================================================================
'  FOR POPUP HELP IN RESPONSE TO A COMMAND BUTTON ...
'====================================================================
    Dim Result As Variant

    Result = WinHelpByStr(m_hWndMainWindow, App.HelpFile, HELP_COMMAND, ByVal (MacroS
tring))
```

```
End Sub
Sub ShowHelpContents()
'=====================================================================
'  DISPLAY HELP STARTUP TOPIC IN RESPONSE TO A COMMAND BUTTON or MENU ...
'=====================================================================
'
    Dim Result As Variant

    Result = WinHelpByNum(m_hWndMainWindow, App.HelpFile, HELP_CONTENTS, CLng(0))

End Sub
Sub ShowContentsTab()
'=====================================================================
'  DISPLAY Contents tab (*.CNT)
'=====================================================================
'
    Dim Result As Variant

    Result = WinHelpByNum(m_hWndMainWindow, App.HelpFile, HELP_FINDER, CLng(0))

End Sub
Sub ShowHelpOnHelp()
'=====================================================================
'  DISPLAY HELP for WINHELP.EXE  ...
'=====================================================================
'
    Dim Result As Variant

    Result = WinHelpByNum(m_hWndMainWindow, App.HelpFile, HELP_HELPONHELP, CLng(0))

End Sub

Sub SearchHelp()
'=====================================================================
'  TO ADD KEYWORD SEARCH CAPABILITY...
'=====================================================================
'     o   In your Help|Search menu selection, simply enter:
'         Call SearchHelp() 'To invoke helpfile keyword search dialog
'
    Dim Result As Variant

    Result = WinHelp(m_hWndMainWindow, App.HelpFile, HELP_PARTIALKEY, ByVal "")

End Sub

Sub SearchHelpKeyWord(Argument As String)
'=====================================================================
'  TO ADD KEYWORD SEARCH CAPABILITY...
'=====================================================================
'     o   In your Help|Search menu selection, simply enter:
'         Call SearchHelp() 'To invoke helpfile keyword search dialog
'
    Dim Result As Variant

    Result = WinHelp(m_hWndMainWindow, App.HelpFile, HELP_PARTIALKEY, ByVal Trim$(Arg
ument))

End Sub
Sub HelpWindowSize(X As Integer, Y As Integer, wx As Integer, wy As Integer)
'=====================================================================
'  TO SET THE SIZE AND POSITION OF THE MAIN HELP WINDOW...
'=====================================================================
'     o   Call HelpWindowSize(x, y, dx, dy), where:
'             x = 1-1024 (position from left edge of screen)
```

```
'               y = 1-1024 (position from top of screen)
'               dx= 1-1024 (width)
'               dy= 1-1024 (height)
'
    Dim Result As Variant
    MainWindowInfo.X = X
    MainWindowInfo.Y = Y
    MainWindowInfo.dX = wx
    MainWindowInfo.dY = wy
    Result = WinHelpByInfo(m_hWndMainWindow, App.HelpFile, HELP_SETWINPOS, MainWindow
Info)
End Sub
```

```
Public dbES As Database
Public rsFilter As Recordset

Public sgEScore(1000) As Single          'Estimate Score
Public sgCostOverrun(1000) As Single     'Cost overrun
Public inNumProjects As Integer          '# of projects returned from query

Public sgDivScore(5) As Single           'Division score  for text box totals
Public sgDivPossible(5) As Single        'Total possible (if 5 selected for each eleme
nt)
Public inDivCount(5) As Integer          '# of elements in each division

Public inWithin As Integer               '<Within Limits> confidence interval flag
Public inMethod As Integer               '<Best-Fit Model> flag
Public inNoContingency As Integer        '<Base + Contingency> flag
Public inAll(2) As Integer               '<Any> or <All> flags

Public inNumEstimates As Integer         '# of estimates in db for a given project
Public inNewFlag As Integer              'New estimate flag
Public inRCount As Integer               'Record count
Public inButtons As Integer              'Message box buttons
Public stMSG As String                   'Message box message
Public inResponse As Integer             'Message box response
Public stProjectName As String           'Project ID
Public stProjectType As String           'Project type
Public stProjectSub As String            'Project sub-type
Public stProjectDispos As String         'Project classification

Public sgSumXX, sgMaxY, sgMinY As Single     'For calculating standard deviations, etc
.
Public sgErrorVarianceHat, sgSSE, sgC As Single     'For calculating confidence bands
, etc.
Public stDBName As String                'Database name

Public stTip As String                   'ToolTip text
Public sgToolLeft, sgToolTop As Single   'ToolTip locations

Public qdFilter As QueryDef              'QueryDef for filter query

Public stFirst, stSecond, stStatsOperator As String     'Stats form text values

'Function to add commas to text boxes with large numbers
Public Function AddCommas(stCommaValue As String) As String
Dim dbValue As Double
Dim stNewValue As String

stCommaValue = StripCommas(stCommaValue)

If stCommaValue = "" Then
    AddCommas = ""
Else
    dbValue = Val(stCommaValue)
    stNewValue = Format(dbValue, "#,###,###,###,##0")
    AddCommas = stNewValue
End If

End Function


'Function to strip commas from text boxes with large numbers
Public Function StripCommas(stCommaValue As String) As Variant
Dim inCount As Integer
Dim stNewValue As String
```

```
'Step through text to eliminate commas & spaces
For inCount = 1 To Len(stCommaValue)
    If Mid(stCommaValue, inCount, 1) <> "," And Mid(stCommaValue, inCount, 1) <> " "
Then
        stNewValue = stNewValue & Mid(stCommaValue, inCount, 1)
    End If
Next inCount

'If the text contains only commas & spaces, return NULL string
If stNewValue = "" Then
    StripCommas = stNewValue
'If the text contains alpha characters, return the text as is
ElseIf Val(stNewValue) = 0 And Mid(stNewValue, 1, 1) <> "0" Then
    StripCommas = stCommaValue
'If the text contains numbers, return the value
Else
    StripCommas = Val(stNewValue)
End If

End Function




Sub main()

    Dim rsWeights As Recordset          'Recordset for element weights
    Dim rsDivision As Recordset         'Recordset for division titles
    Dim inCount, inCountJ As Integer    'Counters
    Dim stOptTip, stOptTipName, stWeightName, stWeight As String    'ToolTips and wei
ght info from db
    Dim stSpaces, stLblTip, stLabel, stElement As String        'ToolTips and element
 descriptions
    Dim stSQL As String                 'SQL text for quering db
    Dim stES, stDivision As String      'ES element # and division # from db
    Dim inES, inDivision, inElement As Integer  'ES element # and division # calculat
ed (converted)


frmIntro.Show                                    'Show "ESP" logo
stDBName = CurDir & "\ESP.MDB"                   'Identify db location as in current d
irectory
frmScoreSheet.datAll.DatabaseName = stDBName     'Setup datAll Data control
frmScoreSheet.datAll.RecordSource = "Project"    'Setup datAll Data control
frmScoreSheet.datAll.Refresh                     'Setup datAll Data control
frmScoreSheet.datAll.UpdateControls              'Setup datAll Data control
frmScoreSheet.datProject.DatabaseName = stDBName     'Setup datProject Data control
frmScoreSheet.datProject.RecordSource = "Project"    'Setup datProject Data control
frmScoreSheet.datProject.Refresh                     'Setup datAll Data control
frmScoreSheet.datProject.UpdateControls              'Setup datAll Data control
frmScoreSheet.cboName.ReFill

'Open the ESP.mdb database
Set dbES = Workspaces(0).OpenDatabase(stDBName)

'Establish the default values for various option buttons
Call frmGraphs.optWithin_Click
Call frmGraphs.optOLS_Click
Call frmFilter.optNoContingency_Click
'Disable the <View Graphs> command button on Estimate Score Sheet form
frmScoreSheet.cmdGraph.Enabled = False
```

```
'Set Division Score totals to zero
    For inCount = 1 To 4
        inDivCount(inCount) = 0
    Next inCount

'Get element weights from the database
    stSQL = "SELECT * FROM Weight " _
        & " WHERE Element_Number LIKE 'ES_*'"
    Set rsWeights = dbES.OpenRecordset(stSQL, dbOpenDynaset)

    rsWeights.MoveFirst

    While rsWeights.EOF <> True
        stES = rsWeights("Element_Number")  'Element # as database field ES_d_ee (d=d
iv, e=element)
        inDivision = Val(Mid(stES, 4, 1))    'Extract division #
        inDivCount(inDivision) = inDivCount(inDivision) + 1
        inElement = Val(Mid(stES, 6))        'Extract element #
        inES = (inDivision * 100 + inElement) * 10  'Build element # as ddee (d=div,
e=element)
        'Get element weight and ToolTip text for each element rating (0 to 5)
        For inCount = 1 To 5
            stWeightName = CStr(inCount) & "_Weight"
            stOptTipName = CStr(inCount) & "_Help"
            If inCount = 0 Then
                stOptTip = "Not Applicable"
            Else
                stOptTip = " " & rsWeights(stOptTipName) & " "
                stLblTip = " " & rsWeights("Help_Question") & " "
            End If
            If inElement < 10 Then
                stElement = CStr(inElement) & "     "
            Else
                stElement = CStr(inElement) & "  "
            End If
            stLabel = CStr(inDivision) & "." & stElement & rsWeights("Element_Descrip
tion")
            stWeight = rsWeights(stWeightName)
            stSpaces = ""
            For inCountJ = 0 To 10 - Len(stWeight)
                stSpaces = stSpaces & " "
            Next inCountJ
            'Store ToolTip text in the Tag property of the option buttons and labels
            frmScoreSheet.optERI(inES + inCount).Tag = stWeight & stSpaces & stOptTip
            frmScoreSheet.lblERI(inES / 10).Tag = stLblTip
            'Fill in the element label on the Estimate Score Sheet form
            frmScoreSheet.lblERI(inES / 10).Caption = stLabel
        Next inCount
        rsWeights.MoveNext

        'Make visible all element labels and option buttons for which elements exist
        For inCount = 1 To 4
            For inCountJ = 1 To inDivCount(inCount)
                frmScoreSheet.fraERI(inCount * 100 + inCountJ).Visible = True
                frmScoreSheet.lblERI(inCount * 100 + inCountJ).Visible = True
                frmScoreSheet.txtERI(inCount * 100 + inCountJ).Visible = True
            Next inCountJ
        Next inCount
    Wend

    'Get division titles from database and fill in division labels on ESS form
    stSQL = "SELECT * FROM Division "
    Set rsDivision = dbES.OpenRecordset(stSQL, dbOpenDynaset)
```

```
    rsDivision.MoveFirst

    While rsDivision.EOF <> True
        inDivision = rsDivision("Division_Number")
        stDivision = rsDivision("Division_Description")
        frmScoreSheet.lblDivision(inDivision).Caption = stDivision
        rsDivision.MoveNext
    Wend

    inNewFlag = 0

End Sub
'Subroutine to fill combo boxes with pertinent info from database
Public Sub FillCombo(objComboBox As Object, stTableName As String, stFieldName As Str
ing, stText As String)
    'objComboBox = combo box to be filled in
    'stTableName = name of table in database
    'stFieldName = name of field in the above table
    'stText = default text value (if any) for combo box
Dim stNames(2000) As String     'Storage for the items to be placed in the combo box
list
Dim inCount As Integer          'Counter
Dim inNumNames As Integer       '# of items to be placed in the combo box
Dim inISFlag As Integer         'FLAG for whether or not item is already in the list

objComboBox.Clear
frmScoreSheet.datAll.RecordSource = stTableName
frmScoreSheet.datAll.Refresh
frmScoreSheet.datAll.Recordset.MoveFirst

inNumNames = 0
'If default text, add as first item in the list
If stText <> "" Then
    objComboBox.AddItem stText
    objComboBox.Text = stText
    stNames(inNumNames) = stText
    inNumNames = inNumNames + 1
'If no default text, add first item from database
Else
    stNames(inNumNames) = frmScoreSheet.datAll.Recordset(stFieldName)
    If stNames(inNumNames) <> "" Then
        objComboBox.AddItem stNames(inNumNames)
        objComboBox.Text = stNames(inNumNames)
    End If
    If Not (frmScoreSheet.datAll.Recordset.EOF) Then
        frmScoreSheet.datAll.Recordset.MoveNext
    End If
End If
inISFlag = 0

'Cycle through database table.field until all records are accounted for
Do Until frmScoreSheet.datAll.Recordset.EOF
    For inCount = 0 To inNumNames
        If frmScoreSheet.datAll.Recordset(stFieldName) = stNames(inCount) Then
            inISFlag = 1
        End If
    Next inCount
    'If item is not already in the list, add it to the list
    If inISFlag <> 1 Then
        inNumNames = inNumNames + 1
        'If an alpha-numeric value appears in the field
        If frmScoreSheet.datAll.Recordset(stFieldName) >= "A" Then
            stNames(inNumNames) = frmScoreSheet.datAll.Recordset(stFieldName)
            objComboBox.AddItem stNames(inNumNames)
```

```
        End If
    End If
    inISFlag = 0
    frmScoreSheet.datAll.Recordset.MoveNext
Loop

End Sub

'Function to compute the Gamma function
Public Function Gamma(dbNumber As Double) As Double
    Dim dbCount As Double
    Dim dbValue, dbK, dbStep As Double


If dbNumber >= 2 Then
    Gamma = (dbNumber - 1) * Gamma(dbNumber - 1)
ElseIf dbNumber = 1 Then
    Gamma = 1
ElseIf dbNumber = 1.5 Then
    Gamma = 0.886226925
ElseIf dbNumber = 0.5 Then
    Gamma = 1.772453851
Else
    dbValue = 0
    dbK = dbNumber - 1
    dbStep = 0.01
    For dbCount = 0.01 To 10 Step dbStep
        dbValue = dbValue + dbCount ^ dbK * Exp(-dbCount) * dbStep
    Next dbCount
    Gamma = dbValue
End If


End Function

'Function to compute a point-value of the t-distribution
Public Function TInv(dbAlpha As Double, inDF As Integer) As Single
    Dim dbNumerator, dbDenominator As Double
    Dim PI As Double
    PI = 3.14159265358979
    Dim inCount As Integer
    Dim dbX, dbProb, dbStep As Double

dbStep = 0.01
dbProb = 0
If inDF < 0 Then
    TInv = 0
    Exit Function
End If
For dbX = -8 To 0 Step dbStep
    inCount = inCount + 1
    dbNumerator = Gamma((inDF + 1) / 2) * (1 + dbX * dbX / inDF) ^ (-0.5 * (inDF + 1)
)
    dbDenominator = Sqr(PI * inDF) * Gamma(inDF / 2)
    dbProb = dbProb + dbStep * dbNumerator / dbDenominator
    If dbProb >= dbAlpha Then Exit For
Next dbX

    TInv = -dbX

End Function
```

APPENDIX H

ESP DATABASE TABLE DEFINITIONS

Properties

Date Created:	10/1/97 10:27:25 PM	Def. Updatable:	Yes
Last Updated:	10/1/97 10:28:23 PM	Record Count:	4

Columns

Name		Type	Size
Division_Number		Number (Integer)	2
Allow Zero Length:	No		
Attributes:	Fixed Size		
Collating Order:	Unknown or Undefined		
Column Hidden:	No		
Column Order:	Default		
Column Width:	Default		
Data Updatable:	No		
Decimal Places:	Auto		
Default Value:	0		
Ordinal Position:	1		
Required:	No		
Source Field:	Division_Number		
Source Table:	Division		
Validate On Set:	No		
Division_Description		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	7635		
Data Updatable:	No		
Ordinal Position:	2		
Required:	No		
Source Field:	Division_Description		
Source Table:	Division		
Validate On Set:	No		

Properties

Date Created:	3/27/97 12:43:07 AM	Def. Updatable:	Yes
Last Updated:	10/23/98 2:32:12 AM	Record Count:	79

Columns

Name		Type	Size
Estimate_ID		Number (Integer)	2
Allow Zero Length:	No		
Attributes:	Fixed Size		
Collating Order:	Unknown or Undefined		
Column Hidden:	No		
Column Order:	Default		
Column Width:	1125		
Data Updatable:	No		
Decimal Places:	Auto		
Default Value:	0		
Ordinal Position:	1		
Required:	No		
Source Field:	Estimate_ID		
Source Table:	Estimate		
Validate On Set:	No		
Project_ID		Number (Integer)	2
Allow Zero Length:	No		
Attributes:	Fixed Size		
Collating Order:	Unknown or Undefined		
Column Hidden:	No		
Column Order:	Default		
Column Width:	1005		
Data Updatable:	No		
Decimal Places:	0		
Default Value:	0		
Ordinal Position:	2		
Required:	1		
Source Field:	Project_ID		
Source Table:	Estimate		
Validate On Set:	No		
Extenuating		Yes/No	1
Allow Zero Length:	No		
Attributes:	Fixed Size		
Collating Order:	Unknown or Undefined		
Column Hidden:	No		
Column Order:	Default		
Column Width:	1110		
Data Updatable:	No		
Default Value:	No		
Format:	Yes/No		

Ordinal Position:	5		
Required:	1		
Source Field:	Extenuating		
Source Table:	Estimate		
Validate On Set:	No		
Estimate_Comments		Text	255
Allow Zero Length:	Yes		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	255		
Data Updatable:	No		
Ordinal Position:	6		
Required:	No		
Source Field:	Estimate_Comments		
Source Table:	Estimate		
Validate On Set:	No		
Chief_Estimator		Text	50
Allow Zero Length:	Yes		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	255		
Data Updatable:	No		
Ordinal Position:	7		
Required:	No		
Source Field:	Chief_Estimator		
Source Table:	Estimate		
Validate On Set:	No		
Estimate_Description		Text	50
Allow Zero Length:	Yes		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	255		
Data Updatable:	No		
Ordinal Position:	8		
Required:	No		
Source Field:	Estimate_Description		
Source Table:	Estimate		
Validate On Set:	No		
Estimate_Date		Date/Time	8
Allow Zero Length:	No		
Attributes:	Fixed Size		
Collating Order:	Unknown or Undefined		
Column Hidden:	No		

Column Order:	Default	
Column Width:	255	
Data Updatable:	No	
Ordinal Position:	9	
Required:	No	
Source Field:	Estimate_Date	
Source Table:	Estimate	
Validate On Set:	No	
Estimated_Engineering_Design	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	255	
Data Updatable:	No	
Decimal Places:	Auto	
Format:	General Number	
Ordinal Position:	10	
Required:	No	
Source Field:	Estimated_Engineering_Design	
Source Table:	Estimate	
Validate On Set:	No	
Estimated_Engineered_Equipment	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	255	
Data Updatable:	No	
Decimal Places:	Auto	
Format:	General Number	
Ordinal Position:	11	
Required:	No	
Source Field:	Estimated_Engineered_Equipment	
Source Table:	Estimate	
Validate On Set:	No	
Estimated_Bulk_Materials	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	255	
Data Updatable:	No	
Decimal Places:	Auto	
Default Value:	0	
Ordinal Position:	12	
Required:	No	

	Source Field:	Estimated_Bulk_Materials	
	Source Table:	Estimate	
	Validate On Set:	No	
Estimated_Construction		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	255	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	13	
	Required:	No	
	Source Field:	Estimated_Construction	
	Source Table:	Estimate	
	Validate On Set:	No	
Estimated_Owner_Costs		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	255	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	14	
	Required:	No	
	Source Field:	Estimated_Owner_Costs	
	Source Table:	Estimate	
	Validate On Set:	No	
Estimated_Other_Costs		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	255	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	15	
	Required:	No	
	Source Field:	Estimated_Other_Costs	
	Source Table:	Estimate	
	Validate On Set:	No	
Estimated_Other_Costs_Description		Text	255

Allow Zero Length:	Yes	
Attributes:	Variable Length	
Collating Order:	General	
Column Hidden:	No	
Column Order:	Default	
Column Width:	255	
Data Updatable:	No	
Ordinal Position:	16	
Required:	No	
Source Field:	Estimated_Other_Costs_Description	
Source Table:	Estimate	
Validate On Set:	No	

Contingency	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	255	
Data Updatable:	No	
Decimal Places:	Auto	
Format:	General Number	
Ordinal Position:	17	
Required:	No	
Source Field:	Contingency	
Source Table:	Estimate	
Validate On Set:	No	

Estimated_Total	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	255	
Data Updatable:	No	
Decimal Places:	Auto	
Format:	General Number	
Ordinal Position:	18	
Required:	No	
Source Field:	Estimated_Total	
Source Table:	Estimate	
Validate On Set:	No	

Estimated_Schedule	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	255	
Data Updatable:	No	

	Decimal Places:	Auto	
	Default Value:	0	
	Ordinal Position:	19	
	Required:	No	
	Source Field:	Estimated_Schedule	
	Source Table:	Estimate	
	Validate On Set:	No	
Business_Unit_Study		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	255	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Default Value:	0	
	Ordinal Position:	20	
	Required:	No	
	Source Field:	Business_Unit_Study	
	Source Table:	Estimate	
	Validate On Set:	No	
Preliminary_Engineering		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	255	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Default Value:	0	
	Ordinal Position:	21	
	Required:	No	
	Source Field:	Preliminary_Engineering	
	Source Table:	Estimate	
	Validate On Set:	No	
Detailed_Engineering		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	255	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Default Value:	0	
	Ordinal Position:	22	
	Required:	No	
	Source Field:	Detailed_Engineering	

	Source Table:	Estimate	
	Validate On Set:	No	
Procurement		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	255	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Default Value:	0	
	Ordinal Position:	23	
	Required:	No	
	Source Field:	Procurement	
	Source Table:	Estimate	
	Validate On Set:	No	
Construction		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	255	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Default Value:	0	
	Ordinal Position:	24	
	Required:	No	
	Source Field:	Construction	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_1_1		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	765	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	26	
	Required:	No	
	Source Field:	ES_1_1	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_1_2		Number (Integer)	2
	Allow Zero Length:	No	

	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	27	
	Required:	No	
	Source Field:	ES_1_2	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_1_3		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	28	
	Required:	No	
	Source Field:	ES_1_3	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_1_4		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	29	
	Required:	No	
	Source Field:	ES_1_4	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_1_5		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	

	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	30	
	Required:	No	
	Source Field:	ES_1_5	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_1_6		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	31	
	Required:	No	
	Source Field:	ES_1_6	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_1_7		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	32	
	Required:	No	
	Source Field:	ES_1_7	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_1_8		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	33	
	Required:	No	

	Source Field:	ES_1_8	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_1_9		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	34	
	Required:	No	
	Source Field:	ES_1_9	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_2_1		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	35	
	Required:	No	
	Source Field:	ES_2_1	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_2_2		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	36	
	Required:	No	
	Source Field:	ES_2_2	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_2_3		Number (Integer)	2

	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	37	
	Required:	No	
	Source Field:	ES_2_3	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_2_4		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	38	
	Required:	No	
	Source Field:	ES_2_4	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_2_5		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	39	
	Required:	No	
	Source Field:	ES_2_5	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_2_6		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	

	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	40	
	Required:	No	
	Source Field:	ES_2_6	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_2_7		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	41	
	Required:	No	
	Source Field:	ES_2_7	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_2_8		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	42	
	Required:	No	
	Source Field:	ES_2_8	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_2_9		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	43	

	Required:	No	
	Source Field:	ES_2_9	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_2_10		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	44	
	Required:	No	
	Source Field:	ES_2_10	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_2_11		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	45	
	Required:	No	
	Source Field:	ES_2_11	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_1		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	46	
	Required:	No	
	Source Field:	ES_3_1	
	Source Table:	Estimate	
	Validate On Set:	No	

ES_3_2		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	47	
	Required:	No	
	Source Field:	ES_3_2	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_3		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	48	
	Required:	No	
	Source Field:	ES_3_3	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_4		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	765	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	49	
	Required:	No	
	Source Field:	ES_3_4	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_5		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	

	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	50	
	Required:	No	
	Source Field:	ES_3_5	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_6		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	51	
	Required:	No	
	Source Field:	ES_3_6	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_7		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	52	
	Required:	No	
	Source Field:	ES_3_7	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_8		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	

	Ordinal Position:	53	
	Required:	No	
	Source Field:	ES_3_8	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_9		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	54	
	Required:	No	
	Source Field:	ES_3_9	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_10		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	55	
	Required:	No	
	Source Field:	ES_3_10	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_11		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	56	
	Required:	No	
	Source Field:	ES_3_11	
	Source Table:	Estimate	
	Validate On Set:	No	

ES_3_12		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	57	
	Required:	No	
	Source Field:	ES_3_12	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_13		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	58	
	Required:	No	
	Source Field:	ES_3_13	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_3_14		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	870	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	59	
	Required:	No	
	Source Field:	ES_3_14	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_4_1		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	

	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	60	
	Required:	No	
	Source Field:	ES_4_1	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_4_2		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	61	
	Required:	No	
	Source Field:	ES_4_2	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_4_3		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	62	
	Required:	No	
	Source Field:	ES_4_3	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_4_4		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	

	Ordinal Position:	63	
	Required:	No	
	Source Field:	ES_4_4	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_4_5		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Default Value:	0	
	Ordinal Position:	64	
	Required:	No	
	Source Field:	ES_4_5	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_4_6		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	65	
	Required:	No	
	Source Field:	ES_4_6	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_4_7		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	66	
	Required:	No	
	Source Field:	ES_4_7	
	Source Table:	Estimate	
	Validate On Set:	No	

ES_4_8		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	67	
	Required:	No	
	Source Field:	ES_4_8	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_4_9		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	68	
	Required:	No	
	Source Field:	ES_4_9	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_4_10		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	465	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	69	
	Required:	No	
	Source Field:	ES_4_10	
	Source Table:	Estimate	
	Validate On Set:	No	
ES_4_11		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	

Column Order:	Default
Column Width:	465
Data Updatable:	No
Decimal Places:	Auto
Default Value:	0
Ordinal Position:	70
Required:	No
Source Field:	ES_4_11
Source Table:	Estimate
Validate On Set:	No

Relationships

Reference

Project			**Estimate**
Project_ID	1	1	Project_ID

Attributes: One to One, Not Enforced

Properties

Date Created:	4/15/97 10:45:00 PM	Def. Updatable:	Yes
Last Updated:	4/30/98 2:13:08 PM	Record Count:	10

Columns

Name		Type	Size
Operator		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	1		
Column Width:	2925		
Data Updatable:	No		
Ordinal Position:	1		
Required:	No		
Source Field:	Operator		
Source Table:	Operator		
Validate On Set:	No		
Operator_Use		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	Default		
Data Updatable:	No		
Ordinal Position:	2		
Required:	No		
Source Field:	Operator_Use		
Source Table:	Operator		
Validate On Set:	No		

Properties

Date Created:	3/27/97 12:48:43 AM	Def. Updatable:	Yes
Last Updated:	10/23/98 2:28:05 AM	Record Count:	90

Columns

Name		Type	Size
Project_Name		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	Default		
Data Updatable:	No		
Ordinal Position:	1		
Required:	1		
Source Field:	Project_Name		
Source Table:	Project		
Validate On Set:	No		
Project_ID		Number (Long)	4
Allow Zero Length:	No		
Attributes:	Fixed Size, Auto-Increment		
Collating Order:	Unknown or Undefined		
Column Hidden:	No		
Column Order:	Default		
Column Width:	1005		
Data Updatable:	No		
Ordinal Position:	2		
Required:	No		
Source Field:	Project_ID		
Source Table:	Project		
Validate On Set:	No		
Company_Name		Text	50
Allow Zero Length:	Yes		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	1080		
Data Updatable:	No		
Ordinal Position:	4		
Required:	No		
Source Field:	Company_Name		
Source Table:	Project		
Validate On Set:	No		

Owner_Client		Text	50
	Allow Zero Length:	Yes	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	1080	
	Data Updatable:	No	
	Ordinal Position:	6	
	Required:	No	
	Source Field:	Owner_Client	
	Source Table:	Project	
	Validate On Set:	No	
Project_Number		Text	255
	Allow Zero Length:	Yes	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	1095	
	Data Updatable:	No	
	Ordinal Position:	7	
	Required:	No	
	Source Field:	Project_Number	
	Source Table:	Project	
	Validate On Set:	No	
Contact_Person		Text	50
	Allow Zero Length:	Yes	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	1050	
	Data Updatable:	No	
	Ordinal Position:	8	
	Required:	No	
	Source Field:	Contact_Person	
	Source Table:	Project	
	Validate On Set:	No	
Contact_Number		Text	50
	Allow Zero Length:	Yes	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	765	
	Data Updatable:	No	
	Ordinal Position:	9	
	Required:	No	
	Source Field:	Contact_Number	

Source Table:	Project	
Validate On Set:	No	
Project_Type	Text	255
Allow Zero Length:	No	
Attributes:	Variable Length	
Collating Order:	General	
Column Hidden:	No	
Column Order:	Default	
Column Width:	825	
Data Updatable:	No	
Ordinal Position:	10	
Required:	No	
Source Field:	Project_Type	
Source Table:	Project	
Validate On Set:	No	
Validation Rule:	"Industrial" Or "Infrastructure" Or "Building" Or Is Null Or "Other"	
Project_Sub_Type	Text	255
Allow Zero Length:	No	
Attributes:	Variable Length	
Collating Order:	General	
Column Hidden:	No	
Column Order:	Default	
Column Width:	2040	
Data Updatable:	No	
Ordinal Position:	11	
Required:	No	
Source Field:	Project_Sub_Type	
Source Table:	Project	
Validate On Set:	No	
Project_Sub_Type_Other	Text	255
Allow Zero Length:	No	
Attributes:	Variable Length	
Collating Order:	General	
Column Hidden:	No	
Column Order:	Default	
Column Width:	Default	
Data Updatable:	No	
Ordinal Position:	12	
Required:	No	
Source Field:	Project_Sub_Type_Other	
Source Table:	Project	
Validate On Set:	No	
Project_Disposition	Text	255
Allow Zero Length:	No	
Attributes:	Variable Length	
Collating Order:	General	
Column Hidden:	No	
Column Order:	Default	
Column Width:	Default	

Data Updatable:	No
Ordinal Position:	13
Required:	No
Source Field:	Project_Disposition
Source Table:	Project
Validate On Set:	No

Project_Disposition_Other	Text	255
Allow Zero Length:	Yes	
Attributes:	Variable Length	
Collating Order:	General	
Column Hidden:	No	
Column Order:	Default	
Column Width:	1260	
Data Updatable:	No	
Ordinal Position:	14	
Required:	No	
Source Field:	Project_Disposition_Other	
Source Table:	Project	
Validate On Set:	No	

Completed_Project	Yes/No	1
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	960	
Data Updatable:	No	
Format:	Yes/No	
Ordinal Position:	15	
Required:	No	
Source Field:	Completed_Project	
Source Table:	Project	
Validate On Set:	No	

Relationships

Reference

Project			Estimate
Project_ID	1	1	Project_ID

Attributes: One to One, Not Enforced

Reference1

Project			Completed_Project
Project_ID	1	1	Project_ID

Attributes: One to One, Not Enforced

Reference2

Project			Project_Type
Project_Type	1	1	Project_Type

Attributes: One to One, Not Enforced

Table Indexes

Name		Number of Fields
PrimaryKey		1
	Clustered:	No
	Distinct Count:	90
	Foreign:	No
	Ignore Nulls:	No
	Name:	PrimaryKey
	Primary:	Yes
	Required:	Yes
	Unique:	Yes
	Fields:	Project_ID, Ascending
ProjectID		1
	Clustered:	No
	Distinct Count:	90
	Foreign:	No
	Ignore Nulls:	No
	Name:	ProjectID
	Primary:	No
	Required:	No
	Unique:	Yes
	Fields:	Project_ID, Ascending

Properties

Date Created:	4/15/97 7:05:24 PM	Def. Updatable:	Yes
Last Updated:	4/27/98 2:48:10 PM	Record Count:	15

Columns

Name		Type	Size
Project_Type		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	Default		
Data Updatable:	No		
Ordinal Position:	1		
Required:	No		
Source Field:	Project_Type		
Source Table:	ProjectCombo		
Validate On Set:	No		
Industrial		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	2040		
Data Updatable:	No		
Ordinal Position:	2		
Required:	No		
Source Field:	Industrial		
Source Table:	ProjectCombo		
Validate On Set:	No		
Building		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	1620		
Data Updatable:	No		
Ordinal Position:	3		
Required:	No		
Source Field:	Building		
Source Table:	ProjectCombo		
Validate On Set:	No		

Infrastructure		Text	50
	Allow Zero Length: No		
	Attributes: Variable Length		
	Collating Order: General		
	Column Hidden: No		
	Column Order: Default		
	Column Width: Default		
	Data Updatable: No		
	Ordinal Position: 4		
	Required: No		
	Source Field: Infrastructure		
	Source Table: ProjectCombo		
	Validate On Set: No		
Other		Text	50
	Allow Zero Length: No		
	Attributes: Variable Length		
	Collating Order: General		
	Column Hidden: No		
	Column Order: Default		
	Column Width: Default		
	Data Updatable: No		
	Ordinal Position: 5		
	Required: No		
	Source Field: Other		
	Source Table: ProjectCombo		
	Validate On Set: No		
Project_Disposition		Text	50
	Allow Zero Length: No		
	Attributes: Variable Length		
	Collating Order: General		
	Column Hidden: No		
	Column Order: Default		
	Column Width: 2115		
	Data Updatable: No		
	Ordinal Position: 6		
	Required: No		
	Source Field: Project_Disposition		
	Source Table: ProjectCombo		
	Validate On Set: No		

Properties

Date Created:	3/27/97 12:59:34 AM	Def. Updatable:	Yes
Last Updated:	4/27/98 2:49:20 PM	Record Count:	17

Columns

Name		Type	Size
Project_Type		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	Default		
Data Updatable:	No		
Ordinal Position:	1		
Required:	No		
Source Field:	Project_Type		
Source Table:	Project_Type		
Validate On Set:	No		
Validation Rule:	"Industrial" Or "Infrastructure" Or "Building" Or "Other" Or Is Null		
Project_Sub_Type		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	2610		
Data Updatable:	No		
Ordinal Position:	2		
Required:	No		
Source Field:	Project_Sub_Type		
Source Table:	Project_Type		
Validate On Set:	No		

Relationships

Reference2

Project			Project_Type
Project_Type	1	1	Project_Type

Attributes: One to One, Not Enforced

Properties

Date Created:	4/12/97 7:09:38 PM	Def. Updatable:	Yes
Last Updated:	10/23/98 2:33:56 AM	Record Count:	24

Columns

Name		Type	Size
Filter		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	1		
Column Width:	2430		
Data Updatable:	No		
Ordinal Position:	1		
Required:	No		
Source Field:	Filter		
Source Table:	Selection		
Validate On Set:	No		
Filter_Use		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	4365		
Data Updatable:	No		
Ordinal Position:	2		
Required:	No		
Source Field:	Filter_Use		
Source Table:	Selection		
Validate On Set:	No		
Field_Type		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	Default		
Data Updatable:	No		
Ordinal Position:	4		
Required:	No		
Source Field:	Field_Type		
Source Table:	Selection		
Validate On Set:	No		

Properties

Date Created:	7/14/97 5:55:04 PM	Def. Updatable:	Yes
Last Updated:	4/30/98 2:10:14 PM	Record Count:	19

Columns

Name		Type	Size
Field		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	1		
Column Width:	3525		
Data Updatable:	No		
Ordinal Position:	1		
Required:	No		
Source Field:	Field		
Source Table:	StatsField		
Validate On Set:	No		
Field_Use		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	3660		
Data Updatable:	No		
Ordinal Position:	2		
Required:	No		
Source Field:	Field_Use		
Source Table:	StatsField		
Validate On Set:	No		

Properties

Date Created:	7/14/97 5:59:25 PM	Def. Updatable:	Yes
Last Updated:	7/14/97 5:59:25 PM	Record Count:	4

Columns

Name		Type	Size
Operator		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	Default		
Data Updatable:	No		
Ordinal Position:	1		
Required:	No		
Source Field:	Operator		
Source Table:	StatsOperator		
Validate On Set:	No		
Operator_Use		Text	50
Allow Zero Length:	No		
Attributes:	Variable Length		
Collating Order:	General		
Column Hidden:	No		
Column Order:	Default		
Column Width:	Default		
Data Updatable:	No		
Ordinal Position:	2		
Required:	No		
Source Field:	Operator_Use		
Source Table:	StatsOperator		
Validate On Set:	No		

Properties

Date Created:	4/5/97 4:36:55 PM	Def. Updatable:	Yes
Last Updated:	10/23/98 2:34:53 AM	Record Count:	49

Columns

Name		Type	Size
Element_Number		Text	8
	Allow Zero Length:	No	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	930	
	Data Updatable:	No	
	Description:	Use the form ES_#_## where the first # is the division # and the second ## is the element #.	
	Ordinal Position:	1	
	Required:	No	
	Source Field:	Element_Number	
	Source Table:	Weight	
	Validate On Set:	No	
1_Weight		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	525	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Default Value:	0	
	Description:	Weight to be applied if a rating of "1" is selected.	
	Format:	General Number	
	Ordinal Position:	3	
	Required:	No	
	Source Field:	1_Weight	
	Source Table:	Weight	
	Validate On Set:	No	
2_Weight		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	525	

Data Updatable:	No	
Decimal Places:	Auto	
Default Value:	0	
Description:	Weight to be applied if a rating of "2" is selected.	
Format:	General Number	
Ordinal Position:	4	
Required:	No	
Source Field:	2_Weight	
Source Table:	Weight	
Validate On Set:	No	
3_Weight	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	525	
Data Updatable:	No	
Decimal Places:	Auto	
Default Value:	0	
Description:	Weight to be applied if a rating of "3" is selected.	
Format:	General Number	
Ordinal Position:	5	
Required:	No	
Source Field:	3_Weight	
Source Table:	Weight	
Validate On Set:	No	
4_Weight	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	525	
Data Updatable:	No	
Decimal Places:	Auto	
Default Value:	0	
Description:	Weight to be applied if a rating of "4" is selected.	
Format:	General Number	
Ordinal Position:	6	
Required:	No	
Source Field:	4_Weight	
Source Table:	Weight	
Validate On Set:	No	
5_Weight	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	

	Column Width:	525	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Default Value:	0	
	Description:	Weight to be applied if a rating of "5" is selected.	
	Format:	General Number	
	Ordinal Position:	7	
	Required:	No	
	Source Field:	5_Weight	
	Source Table:	Weight	
	Validate On Set:	No	
Element_Description		Text	100
	Allow Zero Length:	No	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	4875	
	Data Updatable:	No	
	Ordinal Position:	8	
	Required:	No	
	Source Field:	Element_Description	
	Source Table:	Weight	
	Validate On Set:	No	
Help_Question		Text	128
	Allow Zero Length:	No	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	7455	
	Data Updatable:	No	
	Description:	ToolTip to be shown when cursor moves over element description.	
	Ordinal Position:	9	
	Required:	No	
	Source Field:	Help_Question	
	Source Table:	Weight	
	Validate On Set:	No	
1_Help		Text	100
	Allow Zero Length:	No	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	6195	
	Data Updatable:	No	
	Description:	ToolTip to be shown when cursor moves over rating of "1".	
	Ordinal Position:	10	
	Required:	No	
	Source Field:	1_Help	

	Source Table:	Weight	
	Validate On Set:	No	
2_Help		Text	100
	Allow Zero Length:	No	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	5250	
	Data Updatable:	No	
	Description:	ToolTip to be shown when cursor moves over rating of "2".	
	Ordinal Position:	11	
	Required:	No	
	Source Field:	2_Help	
	Source Table:	Weight	
	Validate On Set:	No	
3_Help		Text	100
	Allow Zero Length:	No	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	5475	
	Data Updatable:	No	
	Description:	ToolTip to be shown when cursor moves over rating of "3".	
	Ordinal Position:	12	
	Required:	No	
	Source Field:	3_Help	
	Source Table:	Weight	
	Validate On Set:	No	
4_Help		Text	100
	Allow Zero Length:	No	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	5115	
	Data Updatable:	No	
	Description:	ToolTip to be shown when cursor moves over rating of "4".	
	Ordinal Position:	13	
	Required:	No	
	Source Field:	4_Help	
	Source Table:	Weight	
	Validate On Set:	No	
5_Help		Text	100
	Allow Zero Length:	No	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	

Column Order:	Default
Column Width:	4950
Data Updatable:	No
Description:	ToolTip to be shown when cursor moves over rating of "5".
Ordinal Position:	14
Required:	No
Source Field:	5_Help
Source Table:	Weight
Validate On Set:	No

Table Indexes

Name	Number of Fields
PrimaryKey	1

Clustered:	No
Distinct Count:	50
Foreign:	No
Ignore Nulls:	No
Name:	PrimaryKey
Primary:	Yes
Required:	Yes
Unique:	Yes
Fields:	Element_Number, Ascending

Properties

Date Created:	3/27/97 12:57:15 AM	Def. Updatable:	Yes
Last Updated:	10/23/98 2:31:07 AM	Record Count:	88

Columns

Name		Type	Size
Project_ID		Number (Integer)	2
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	Default	
	Data Updatable:	No	
	Decimal Places:	0	
	Default Value:	0	
	Ordinal Position:	1	
	Required:	1	
	Source Field:	Project_ID	
	Source Table:	Completed_Project	
	Validate On Set:	No	
Actual_Comments		Text	255
	Allow Zero Length:	Yes	
	Attributes:	Variable Length	
	Collating Order:	General	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	585	
	Data Updatable:	No	
	Ordinal Position:	3	
	Required:	No	
	Source Field:	Actual_Comments	
	Source Table:	Completed_Project	
	Validate On Set:	No	
Actual_Engineering_Design		Number (Double)	8
	Allow Zero Length:	No	
	Attributes:	Fixed Size	
	Collating Order:	Unknown or Undefined	
	Column Hidden:	No	
	Column Order:	Default	
	Column Width:	495	
	Data Updatable:	No	
	Decimal Places:	Auto	
	Format:	General Number	
	Ordinal Position:	4	
	Required:	No	

Source Field:	Actual_Engineering_Design	
Source Table:	Completed_Project	
Validate On Set:	No	
Actual_Engineered_Equipment	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	495	
Data Updatable:	No	
Decimal Places:	Auto	
Format:	General Number	
Ordinal Position:	5	
Required:	No	
Source Field:	Actual_Engineered_Equipment	
Source Table:	Completed_Project	
Validate On Set:	No	
Actual_Bulk_Materials	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	495	
Data Updatable:	No	
Decimal Places:	Auto	
Default Value:	0	
Ordinal Position:	6	
Required:	No	
Source Field:	Actual_Bulk_Materials	
Source Table:	Completed_Project	
Validate On Set:	No	
Actual_Construction	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	495	
Data Updatable:	No	
Decimal Places:	Auto	
Format:	General Number	
Ordinal Position:	7	
Required:	No	
Source Field:	Actual_Construction	
Source Table:	Completed_Project	
Validate On Set:	No	
Actual_Owner_Costs	Number (Double)	8

Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	495	
Data Updatable:	No	
Decimal Places:	Auto	
Format:	General Number	
Ordinal Position:	8	
Required:	No	
Source Field:	Actual_Owner_Costs	
Source Table:	Completed_Project	
Validate On Set:	No	

Actual_Other_Costs	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	1785	
Data Updatable:	No	
Decimal Places:	Auto	
Format:	General Number	
Ordinal Position:	9	
Required:	No	
Source Field:	Actual_Other_Costs	
Source Table:	Completed_Project	
Validate On Set:	No	

Actual_Other_Costs_Description	Text	50
Allow Zero Length:	Yes	
Attributes:	Variable Length	
Collating Order:	General	
Column Hidden:	No	
Column Order:	Default	
Column Width:	840	
Data Updatable:	No	
Ordinal Position:	10	
Required:	No	
Source Field:	Actual_Other_Costs_Description	
Source Table:	Completed_Project	
Validate On Set:	No	

Actual_Total_Calculated	Number (Double)	8
Allow Zero Length:	No	
Attributes:	Fixed Size	
Collating Order:	Unknown or Undefined	
Column Hidden:	No	
Column Order:	Default	
Column Width:	480	
Data Updatable:	No	

Decimal Places:	Auto		
Format:	General Number		
Ordinal Position:	11		
Required:	No		
Source Field:	Actual_Total_Calculated		
Source Table:	Completed_Project		
Validate On Set:	No		
Actual_Total		Number (Double)	8
Allow Zero Length:	No		
Attributes:	Fixed Size		
Collating Order:	Unknown or Undefined		
Column Hidden:	No		
Column Order:	Default		
Column Width:	1650		
Data Updatable:	No		
Decimal Places:	Auto		
Format:	General Number		
Ordinal Position:	12		
Required:	No		
Source Field:	Actual_Total		
Source Table:	Completed_Project		
Validate On Set:	No		
Actual_Schedule		Number (Double)	8
Allow Zero Length:	No		
Attributes:	Fixed Size		
Collating Order:	Unknown or Undefined		
Column Hidden:	No		
Column Order:	Default		
Column Width:	Default		
Data Updatable:	No		
Decimal Places:	Auto		
Default Value:	0		
Ordinal Position:	13		
Required:	No		
Source Field:	Actual_Schedule		
Source Table:	Completed_Project		
Validate On Set:	No		
Actual_Completion		Date/Time	8
Allow Zero Length:	No		
Attributes:	Fixed Size		
Collating Order:	Unknown or Undefined		
Column Hidden:	No		
Column Order:	Default		
Column Width:	Default		
Data Updatable:	No		
Ordinal Position:	14		
Required:	No		
Source Field:	Actual_Completion		
Source Table:	Completed_Project		
Validate On Set:	No		

Relationships

Reference1

Project			Completed_Project
Project_ID	1	1	Project_ID

Attributes: One to One, Not Enforced

APPENDIX I

ESP DATABASE TABLES

Completed_Project Table

Project_ID	Actual_Comments	Actual_Engineering_Design	Actual_Engineered_Equipment	Actual_Bulk_Materials	Actual_Construction	Actual_Owner_Costs	Actual_Other_Costs
1							$ 82,000,000
2		$ 5,200,000	$ 16,500,000		$ 19,100,000	$ 3,800,000	$ -
3							$ 219,302,000
4		$ 3,285,000	$ 61,807,000		$ 28,101,000		$ 6,307,000
5		$ 4,465,000	$ 2,713,000		$ 3,297,000	$ 2,593,000	$ 17,492,000
6		$ 810,000	$ 1,500,000		$ 3,090,000		
7		$ 6,800,000	$ 85,000,000		$ 13,000,000		$ 8,600,000
8		$ 15,900,000	$ 28,400,000		$ 20,200,000	$ -	$ -
9		$ 87,318	$ 480,000		$ 332,682		
10		$ 2,416,044	$ 13,294,614		$ 4,908,200	$ 248,392	$ 883,350
11		$ 3,530,000	$ 5,550,000		$ 17,790,000	$ 1,640,000	
12		$ 4,048,000	$ 7,950,000		$ 8,557,000	$ 6,432,000	$ 2,854,000
13		$ 50,074,000			$ 476,414,000	$ 62,581,000	
14							$ 188,442,000
15		$ 540,000	$ 135,000		$ 1,075,000		
16		$ 172,000	$ 209,000		$ 907,000	$ 20,000	
17		$ 881,545	$ 247,666		$ 1,397,715	$ 406,421	$ 468,030
18							$ 15,300,000
19							$ 22,402,871
20		$ 85,000	$ 533,000		$ 413,000		$ 85,000
21			$ 855,277		$ 1,148,666	$ 695,643	$ 825,902
22		$ 1,899,000	$ 10,419,000		$ 8,620,000	$ 1,877,000	
23		$ 21,404,000	$ 73,062,800		$ 52,000,000		$ 1,800,000
24		$ 1,165,000	$ 1,222,000		$ 4,258,000		
25		$ 505,000	$ 3,057,000		$ 3,185,000	$ 72,000	$ 230,000
26							$ 110,000,000
27							$ 152,000,000
28							$ 74,960,000
29		$ 4,500,000			$ 56,500,000	$ 11,000,000	
30		$ 30,000,000	$ 27,000,000		$ 65,500,000	$ 9,500,000	
31		$ 6,300,000	$ 4,500,000		$ 2,000,000		
32		$ 562,384	$ 385,534		$ 2,420,159		$ 520,258
33		$ 627,000	$ 571,000		$ 2,152,000		
34		$ 123,166,800	$ 254,343,900		$ 352,707,800		$ 80,168,500
35							$ 5,915,000
36		$ 746,000			$ 613,000	$ 2,000	
37		$ 4,095,000	$ 2,596,000	$ 7,373,000	$ 4,253,000		$ 1,821,000
38							$ 8,010,000
39		$ 813,000	$ 6,056,000		$ 3,379,000		$ 30,000
40		$ 1,368,300	$ 3,828,720		$ 3,553,290		$ 261,690
41							$ 239,042,000
42							$ 107,062,000
43							$ 13,600,000
44							$ 60,300,000
45							$ 2,900,000
46							$ 20,235,088
47							$ 36,536,000
48							$ 50,400,000
57							$ 120,000,000
58							$ 2,110,000
59							$ 4,190,000
60							$ 1,980,000
61							$ 94,000,000
62							$ 100,700,000
63							$ 55,800,000
64							$ 12,300,000
65							$ 470,000
66							$ 68,300,000
67							$ 13,300,000
68							$ 11,400,000
69							$ 50,500,000
70							$ 1,494,000
71							$ 83,400,000
72							$ 73,500,000
73							$ 51,300,000
74							$ 178,000,000
75							$ 180,800,000
76							$ 1,750,000
77							$ 557,600,000
78							$ 11,200,000
79							$ 8,700,000
80							$ 14,275,259
81							$ 11,994,026
82							$ 2,339,380
83							$ 3,869,167
84							$ 2,245,029
85							$ 4,310,688
86							$ 4,317,587
87							$ 845,000
88							$ 5,146,100
89							$ 31,792,500
90							$ 617,300
91							$ 6,141,000
92							$ 7,088,000
93							$ 1,016,000
94							$ 16,800,000
95							$ 20,100,000
96							$ 375,000,000
109		$ 40,638,000	$ 69,308,000		$ 50,569,000		

Completed_Project Table

Project_ID	Actual_Other_Costs_Description	Actual_Total_Calculated	Actual_Total	Actual_Schedule	Actual_Completion
1			$ 82,000,000		
2	design allowance and escalation		$ 44,600,000		
3			$ 219,302,000		
4	freight		$ 99,500,000		
5	Control bldg; insulation/paint;...		$ 30,560,000		
6			$ 5,400,000		
7	PM/CM		$ 113,400,000		
8			$ 64,500,000		
9			$ 900,000		
10	License fee		$ 21,750,600		
11			$ 28,510,000		
12			$ 29,841,000		
13			$ 589,069,000		
14			$ 188,442,000		
15			$ 1,750,000		
16			$ 1,308,000		
17	Tank & painting		$ 3,401,377		
18			$ 15,300,000		
19			$ 22,402,871		
20	Startup & Pre-Project Planning		$ 1,116,000		
21			$ 3,525,488		
22			$ 22,815,000		
23			$ 148,266,800		
24			$ 6,645,000		
25	pre/post testing		$ 7,049,000		
26			$ 110,000,000		
27			$ 152,000,000		
28			$ 74,960,000		
29			$ 72,000,000		
30			$ 132,000,000		
31			$ 12,800,000		
32			$ 3,888,335		
33			$ 3,350,000		
34			$ 810,387,000		
35			$ 5,915,000		
36			$ 1,361,000		
37	Subcontracts		$ 20,138,000		2/1/97
38			$ 8,010,000		
39	Startup & Pre-Project Planning		$ 10,278,000		
40	pre-project planning		$ 9,012,000		
41			$ 239,042,000		
42			$ 107,062,000		
43			$ 13,600,000		
44			$ 60,300,000		
45			$ 2,900,000		
46			$ 20,235,088		
47			$ 36,536,000		
48			$ 50,400,000		
57			$ 120,000,000		
58			$ 2,110,000		
59			$ 4,190,000		
60			$ 1,980,000		
61			$ 94,000,000		
62			$ 100,700,000		
63			$ 55,800,000		
64			$ 12,300,000		
65			$ 470,000		
66			$ 68,300,000		
67			$ 13,300,000		
68			$ 11,400,000		
69			$ 50,500,000		
70			$ 1,494,000		
71			$ 83,400,000		
72			$ 73,500,000		
73			$ 51,300,000		
74			$ 178,000,000		
75			$ 180,800,000		
76			$ 1,750,000		
77			$ 557,600,000		
78			$ 11,200,000		
79			$ 8,700,000		
80			$ 14,275,259		
81			$ 11,994,026		
82			$ 2,339,380		
83			$ 3,869,167		
84			$ 2,245,029		
85			$ 4,310,688		
86			$ 4,317,587		
87			$ 845,000		
88			$ 5,146,100		
89			$ 31,792,500		
90			$ 617,300		
91			$ 6,141,000		
92			$ 7,088,000		
93			$ 1,016,000		
94			$ 16,800,000		
95			$ 20,100,000		
96			$ 375,000,000		
109			$ 160,515,000	0	

Division Table

Division_Number	Division_Description
1	WHO WAS INVOLVED IN PREPARING THIS ESTIMATE?
2	HOW WAS THIS ESTIMATE PREPARED?
3	WHAT WAS KNOWN ABOUT THE PROJECT?
4	OTHER FACTORS AFFECTING THIS ESTIMATE.

Estimate Table

Estimate_ID	Project_ID	Extenuating	Estimate_Comments	Chief_Estimator	Estimate_Description
1	1	FALSE		Joe Small	Level 1
1	2	FALSE	Project was within cost and sched until unit shutdown (planned). Contractor then lost control of sched delaying 2 other contractors. (Shutdown planned for 34 days but took 57).		Level 1
1	3	FALSE			Level 1
1	4	FALSE			Level 1
1	5	FALSE		John Big	Level 1
1	6	FALSE			Level 1
1	7	FALSE	Cost data questionable.		Level 1
1	8	FALSE			Level 1
1	9	FALSE			Level 1
1	10	FALSE	Greatly underestimated labor productivity (overseas project). Forgot to include owner's cost for unit prep and commissioning. Sched-driven project.		Level 1
1	11	FALSE			Level 1
1	12	FALSE	EPC project.		Level 1
1	13	FALSE			Level 1
1	14	FALSE			Level 1
1	15	FALSE			Level 1
1	16	FALSE			Level 1
1	17	FALSE			Level 1
1	18	FALSE			Level 1
1	19	FALSE	Project estimated by XXXX. They did not include contingency for unforeseen items (only for undefined scope to be utilized). Thus, zero contingency shown for this estimate.		Level 1
1	20	FALSE	Conversion of a closed process plant to a propane terminal.		Level 1
1	21	FALSE			Level 1
1	22	FALSE			Level 1
1	23	TRUE			Level 1
1	24	FALSE			Level 1
1	25	FALSE			Level 1
1	26	FALSE			Level 1
1	27	FALSE			Level 1
1	28	FALSE			Level 1
1	29	TRUE	Laboratory		Level 1
1	30	FALSE			Level 1
1	31	FALSE			Level 1
1	32	FALSE			Level 1
1	33	FALSE			Level 1
1	34	FALSE			Level 1
1	35	FALSE			Level 1
1	36	FALSE			Level 1
1	37	TRUE	Initial authorization based on a factored estimate and no good basis was available for the factor.		Level 1
1	38	FALSE			Level 1
1	39	FALSE			Level 1
1	40	FALSE			Level 1
1	41	FALSE	Additional costs incurred due to accelerated sched required by client.		Level 1
1	42	FALSE			Level 1
1	43	FALSE			Level 1
1	44	FALSE			Level 1
1	45	FALSE			Level 1
1	46	FALSE			Level 1
1	47	FALSE	2 Hurricanes created extremely unfavorable condition for site work--created excessive demand for workers.		Level 1
1	48	FALSE		John Big	Level 1
1	57	FALSE	Rules/reg's imposed that were not known up front; extraneous costs by multiple subs; foreign location significant impact		Level 1
1	58	TRUE			Level 1
1	59	FALSE			Level 1
1	60	TRUE			Level 1
1	61	FALSE	Scope was not fully defined at estimate time. 5 units as 1 project (1 was new technology). Additional requirements at operational level due to end-user.		Level 1
1	62	FALSE	Major part of project was well scoped & planned. Late add-ons were not as well done & were source of some problems with cost and sched.		Level 1
1	63	FALSE	Major move in project site.		Level 1
1	64	TRUE	Process technology and scope changes; tremendous scope creep throughout most phases.		Level 1
1	65	FALSE			Level 1
1	66	FALSE	Priced equipment underruns; escalation; items not used; EPC job		Level 1
1	67	FALSE	Changed scope & estimate to meet pre-determined capital amount; Project was laundry-list of smaller projects; Different owners with different priorities.		Level 1
1	68	FALSE	Good working relationship between project management and contractor. Heavy cut and fit job.		Level 1
1	69	FALSE	ISBL factors too low; Major equipment quotes too low; Major equipment size increased; Project team witheld key information from cost engineer because they thought the estimate was too high; poor productivity.		Level 1
1	70	TRUE	Change of foundation design; cost-control of engineering manhours.		Level 1
1	71	FALSE	Project scope was poorly defined at the time of the estimate and significant items were added.		Level 1
1	72	FALSE			Level 1
1	73	FALSE			Level 1
1	74	FALSE			Level 1
1	75	FALSE			Level 1
1	76	FALSE			Level 1

Estimate Table

Estimate_ID	Project_ID	Extenuating	Estimate_Comments	Chief_Estimator	Estimate_Description
1	77	FALSE	Technically was IGCC project (coal gasification) and was installed to produce power. From internal technology standpoint, it was a chemical plant.		Level 1
1	78	FALSE	Upscaled version of recently completed project.		Level 1
1	79	FALSE	Process changes during design and construction.		Level 1
1	80	TRUE	Material discounts; bachelor enlisted quarters		Level 1
1	81	TRUE	Very competitive construction market		Level 1
1	82	TRUE	Mark-up factor percentages		Level 1
1	83	TRUE	Mark-up factor percentages		Level 1
1	84	TRUE	Competitive low bidding		Level 1
1	85	TRUE	User requested changes due to uniqueness of facility, technological advancements and lessons learned.		Level 1
1	86	TRUE			Level 1
1	87	FALSE	Phased startup implemented		Level 1
1	88	TRUE	Bidding climate		Level 1
1	89	TRUE	Change in customer mission; project had a very compressed design schedule to meet mission requirements		Level 1
1	90	TRUE	Low bidder's advantage because he is on-site with previously won contract.		Level 1
1	91	FALSE	Changed to a phased startup approach		Level 1
1	92	FALSE	International project		Level 1
1	93	FALSE			Level 1
1	94	FALSE	Scope reduction and project execution plan change resulted in $500,000 savings. Final project startup phase delayed by 5 weeks due to lack of supplier support (sched extension added $300,000 to TIC);		Level 1
1	95	FALSE	Used tight project controls to limit changes to those absolutely needed to meet project objectives (project goals and safety). Near-perfect startup ahead of sched. Const. Safety RIR 1.2 and LTIR zero!		Level 1
1	96	FALSE	Escalation over life of project was less than estimated. Project was stopped twice (2 one-year delays). 24MM of the 32MM contingency was returned to project 1-year prior to startup.		Level 1
1	109	FALSE			Level 1

Estimate Table

Estimate_ID	Project_ID	Estimate_Date	Estimated_Engineering_Design	Estimated_Engineered_Equipmen	Estimated_Bulk_Materials	Estimated_Construction
1	1					
1	2		4600000	13700000		13700000
1	3					
1	4		2403846	61783654		26290481
1	5		3640000	3309000		2727000
1	6		700000	1575000		2564000
1	7		6538462	80384616		12500000
1	8		12400000	29300000		20700000
1	9		113000	501000		382000
1	10		2527000	13112000		2417000
1	11		3560000	8570000		13820000
1	12		4318080	7022740		6064380
1	13					
1	14					
1	15		410000	118000		1075000
1	16		158000	204000		525000
1	17		730330	284759		783233
1	18					
1	19		3750000	9055878		7360572
1	20		72727	490909		254545
1	21			825948		591000
1	22		1300000	11572000		7723000
1	23		25119900	81092700		59384600
1	24		941000	986000		3262000
1	25		530000	2650000		3653000
1	26					
1	27					
1	28					
1	29		4000000			52500000
1	30		26000000	27000000		63500000
1	31					
1	32		454200	293900		2295500
1	33		635000	561000		1952000
1	34		80374100	263957800		184446600
1	35		1757000	1085000		2407000
1	36		555000			684000
1	37	5/1/95	2669000	1580000		4860000
1	38					
1	39		835000	5942000		2215000
1	40		938436	3569406		3169768
1	41		26761000	103168000		54303000
1	42					
1	43					
1	44					
1	45					
1	46					
1	47					
1	48					
1	57					
1	58					
1	59					
1	60					
1	61					
1	62					
1	63					
1	64					
1	65					
1	66					
1	67					
1	68					
1	69					
1	70					
1	71					
1	72					
1	73					
1	74					
1	75					
1	76					

Estimate Table

Estimate_ID	Project_ID	Estimate_Date	Estimated_Engineering_Design	Estimated_Engineered_Equipmen	Estimated_Bulk_Materials	Estimated_Constructio
1	77					
1	78					
1	79					
1	80					
1	81					
1	82					
1	83					
1	84					
1	85					
1	86					
1	87					
1	88					
1	89					
1	90					
1	91					
1	92					
1	93					
1	94					
1	95					
1	96					
1	109		35000000	82000000		57000000

Estimate Table

Estimate_ID	Project_ID	Estimated_Owner_Costs	Estimated_Other_Costs	Estimated_Other_Costs_Description	Contingency	Estimated_Total
1	1		69900000		4900000	74800000
1	2	3900000	800000	design allowance and escalation	2800000	39500000
1	3		177690000		12847000	190537000
1	4		3591250	freight	3762769	97832000
1	5	2454000	15382000	Control bldg; insulation/paint;...	3188000	30700000
1	6				661000	5500000
1	7		8269230	PM/CM	4307692	112000000
1	8	0	0		2300000	64700000
1	9				104000	1100000
1	10	0	883000	License fee	926000	19865000
1	11	2490000			2960000	31400000
1	12	3376000	2854000	Escalation, fee, license	1009800	24645000
1	13		543921000		37579000	581500000
1	14		188600000		13000000	201600000
1	15				147000	1750000
1	16	16000			67000	970000
1	17	381220	384488	Tank & painting	435970	3000000
1	18		13100437		1899563	15000000
1	19	576062	618290	Const interest	0	21360802
1	20		10000	Startup	82819	911000
1	21	680488	331577		241987	2671000
1	22	2843000			1787000	25225000
1	23		23857500	escalation;incentives;sales tax;team bldg;...	24739000	214193700
1	24				1661000	6850000
1	25	184000	140000	Pre/post testing	390000	7547000
1	26		97000000			97000000
1	27		140845070		9154930	150000000
1	28		67300000	includes 5.3MM for const interest	10095000	77395000
1	29	9500000			2000000	68000000
1	30	8500000			25000000	150000000
1	31		14000000			14000000
1	32		755900	expense	241200	4040700
1	33				252000	3400000
1	34		171620100	ocean freight;tariffs;spare parts;catalyst;escalation;fee	38513000	738911600
1	35	68000			313000	5630000
1	36	15000			63000	1317000
1	37		660000	Subcontracts	3578000	13347000
1	38		7520000			7520000
1	39		28000	Startup & Pre-Project Planning	902000	9922000
1	40				303840	7981450
1	41		21640000		11786000	217658000
1	42		106950000	All costs combined	8050000	115000000
1	43		13300000		0	13300000
1	44		52000000		5000000	57000000
1	45		3000000		200000	3200000
1	46		17990000		2000000	19990000
1	47		32701000		1768000	34469000
1	48		47000000		1700000	48700000
1	57		102000000		11000000	113000000
1	58		1550000		200000	1750000
1	59		3660000		200000	3860000
1	60		2560000		440000	3000000
1	61		71200000		4000000	75200000
1	62		95600000		5400000	101000000
1	63		50350000		7650000	58000000
1	64		10700000		600000	11300000
1	65		360000		35000	395000
1	66		68246000		2754000	71000000
1	67		11000000		1500000	12500000
1	68		10000000		2000000	12000000
1	69		35000000		5000000	40000000
1	70		1886000		187000	2073000
1	71		65700000		11900000	77600000
1	72		68000000		4000000	72000000
1	73		55300000		6100000	61400000
1	74		166700000		16700000	183400000
1	75		163200000		25400000	188600000
1	76		1600000		150000	1750000

Estimate Table

Estimate_ID	Project_ID	Estimated_Owner_Costs	Estimated_Other_Costs	Estimated_Other_Costs_Description	Contingency	Estimated_Total
1	77		515000000		21300000	536300000
1	78		12100000			12100000
1	79		9000000			9000000
1	80		15695400			15695400
1	81		13360000			13360000
1	82		2504700			2504700
1	83		4063000			4063000
1	84		2300000		115000	2415000
1	85		3020000		151000	3171000
1	86		4440000		222000	4662000
1	87		864000		36000	900000
1	88		4685000		234250	4919250
1	89		26430000		1321500	27751500
1	90		654000			654000
1	91		5784000		166000	5950000
1	92		6224000		864000	7088000
1	93		1049000		51000	1100000
1	94		17600000		1100000	18700000
1	95		22950000		150000	23100000
1	96		373000000		32000000	405000000
1	109				15000000	189000000

Estimate Table

Estimate_ID	Project_ID	Estimated_Schedule	Business_Unit_Study	Preliminary_Engineering	Detailed_Engineering	Procurement	Construction	ES_1_1	ES_1_2	ES_1_3
1	1							1	2	2
1	2							2	1	1
1	3							3	2	1
1	4							5	5	3
1	5							3	2	1
1	6							2	2	3
1	7							3	1	1
1	8							1	1	1
1	9							1	1	1
1	10							3	2	2
1	11							1	2	1
1	12							4	1	2
1	13							3	2	2
1	14							2	2	2
1	15							2	2	3
1	16							3	3	3
1	17							3	3	2
1	18							1	2	2
1	19							2	3	2
1	20							3	3	2
1	21							3	3	2
1	22							4	3	3
1	23							2	2	1
1	24							2	4	2
1	25							2	2	1
1	26							4	2	3
1	27							4	5	3
1	28							1	2	2
1	29							3	2	2
1	30							2	2	1
1	31							2	2	2
1	32							1	2	2
1	33							1	2	3
1	34							2	2	2
1	35							3	2	2
1	36							2	2	2
1	37							2	2	4
1	38							2	3	2
1	39							2	3	2
1	40							2	3	2
1	41		100	95	5	25	0	2	3	3
1	42		100	80	0	40	0	2	3	2
1	43							4	2	2
1	44							4	1	1
1	45							4	2	1
1	46							4	3	2
1	47		90	90	0	0	0	2	1	3
1	48		100	90	0			2	2	3
1	57		85	2	0	0	0	2	3	2
1	58		100	100	70			1	2	2
1	59		100	100	10			2	2	2
1	60		100	100	90			1	2	2
1	61		100	70	5			2	1	2
1	62		90	90	30			3	2	2
1	63		90	70	20			2	2	1
1	64		80	85	0			2	4	2
1	65		100	80	0			2	2	2
1	66		1	5	25			2	1	1
1	67		50	25	0			3	3	4
1	68		100	5	0			3	1	3
1	69		100	5	0	0	0	3	4	3
1	70		100	80	25			1	2	2
1	71		75	25	0			2	3	1
1	72		100	10	0			4	1	1
1	73		100	90	0			2	1	1
1	74		100	100	5			1	1	1
1	75		100	100	0			1	1	2
1	76		100	100	20			2	2	3

Estimate Table

Estimate_ID	Project_ID	Estimated_Schedule	Business_Unit_Study	Preliminary_Engineering	Detailed_Engineering	Procurement	Construction	ES_1_1	ES_1_2	ES_1_3
1	77		100	100	50			2	1	1
1	78		80	50	10			0	3	1
1	79		90	50	10			0	2	3
1	80		100	100	100			1	1	1
1	81		100	100	100			1	1	1
1	82		100	100	100			2	1	1
1	83		100	100	100			2	1	1
1	84		100	100	100			1	1	1
1	85		100	100	100			1	1	1
1	86		100	100	30			1	1	1
1	87		100	100	10			2	2	2
1	88		100	100	50			3	1	1
1	89		100	100	100			5	2	2
1	90		100	100	100			2	1	1
1	91		100	100	10			2	2	2
1	92		100	90	10			2	3	4
1	93		100		0			2	2	2
1	94		100	90	0			3	3	2
1	95		100	100	0			2	2	1
1	96		90	50	5			2	3	2
1	109	0						2	1	2

Estimate Table

Estimate_ID	Project_ID	ES_1_4	ES_1_5	ES_1_6	ES_1_7	ES_1_8	ES_1_9	ES_2_1	ES_2_2	ES_2_3	ES_2_4	ES_2_5	ES_2_6	ES_2_7	ES_2_8	ES_2_9	ES_2_10
1	1	1	3	2	4	2	2	2	2	2	3	2	2	4	2	4	4
1	2	1	2	2	3	1	3	1	1	2	2	2	1	2	2	2	1
1	3	2	2	1	3	1	3	2	2	3	3	2	1	2	1	3	1
1	4	5	4	4	3	4	2	3	3	4	5	2	4	4	4	5	5
1	5	1	2	1	2	1	1	1	1	2	1	2	2	1	1	1	1
1	6	2	2	1	3	1	3	1	2	3	1	2	2	2	1	2	2
1	7	1	4	4	2	1	2	3	1	2	2	2	2	3	2	5	2
1	8	1	5	1	1	1	3	1	1	1	2	2	2	1	1	2	1
1	9	1	1	1	2	1	1	1	1	1	1	1	1	1	1	2	1
1	10	1	3	2	2	1	2	3	3	3	3	4	3	4	1	4	2
1	11	1	2	1	1	1	4	1	1	2	3	2	1	2	2	3	1
1	12	1	3	2	4	1	3	2	2	2	2	4	2	1	1	2	1
1	13	2	2	2	3	1	3	2	2	2	1	2	2	2	2	3	2
1	14	1	2	2	1	1	3	2	2	2	2	2	2	2	2	3	2
1	15	1	3	1	2	2	3	2	2	2	4	2	2	3	1	3	3
1	16	2	4	4	5	2	4	2	3	3	3	5	4	3	2	3	3
1	17	1	3	3	3	1	3	1	2	2	2	2	2	2	2	3	2
1	18	1	3	4	3	2	3	1	1	2	2	4	2	2	2	3	2
1	19	3	2	2	3	3	3	3	2	3	3	3	4	3	2	2	3
1	20	2	4	3	4	2	4	4	3	3	3	2	3	2	3	5	3
1	21	2	4	3	4	2	4	4	3	3	3	2	3	2	3	5	3
1	22	2	4	3	3	1	2	1	2	2	2	2	2	2	2	3	2
1	23	2	3	1	2	1	3	2	2	3	3	2	1	2	1	3	1
1	24	1	4	1	3	2	3	3	2	3	2	4	2	3	3	4	2
1	25	1	2	2	3	2	2	2	2	2	3	4	2	3	2	3	2
1	26	5	4	4	3	4	4	1	1	1	4	4	3	2	1	3	3
1	27	1	4	1	3	4	3	1	3	2	2	2	1	1	3	4	2
1	28	1	2	3	2	1	2	2	2	3	4	4	3	3	3	3	2
1	29	2	3	1	2	2	1	2	1	2	3	2	3	2	2	2	2
1	30	2	1	1	2	2	2	1	1	2	1	1	1	1	1	2	1
1	31	1	2	2	1	1	2	2	1	2	2	1	1	2	2	3	2
1	32	1	1	1	1	1	2	1	1	2	1	2	2	1	1	1	1
1	33	2	3	1	3	1	3	2	2	3	4	2	2	2	1	3	2
1	34	2	2	1	4	1	4	3	3	3	2	4	1	2	2	3	2
1	35	1	2	2	3	2	2	3	3	3	4	4	2	1	2	3	2
1	36	2	2	2	2	2	2	3	3	3	4	4	2	1	3	2	2
1	37	1	4	3	3	2	4	2	3	3	3	2	2	2	2	4	3
1	38	4	3	4	4	2	3	3	3	5	5	4	4	4	4	3	3
1	39	2	3	3	3	2	3	3	3	3	2	4	2	2	2	2	2
1	40	2	3	3	3	2	3	3	3	3	2	4	2	2	2	2	2
1	41	2	2	2	2	1	3	2	1	3	2	2	2	2	1	3	2
1	42	1	3	3	3	2	3	3	3	3	4	2	2	2	2	3	2
1	43	1	3	1	3	1	4	1	2	3	3	4	2	2	1	3	1
1	44	3	4	3	5	1	2	3	2	2	4	3	2	3	2	4	2
1	45	2	3	2	3	4	3	2	4	2	3	2	5	3	2	2	4
1	46	2	2	1	3	2	1	2	2	2	4	3	3	2	2	4	2
1	47	4	3	3	3	3	3	4	2	4	4	2	3	3	4	4	5
1	48	4	3	2	2	2	2	1	1	2	1	1	2	2	2	2	1
1	57	2	3	2	5	2	5	4	3	3	4	3	2	2	2	2	2
1	58	1	2	2	2	1	2	1	2	2	2	3	2	2	2	3	3
1	59	1	2	2	3	1	3	2	3	2	2	3	2	2	2	3	2
1	60	1	3	3	2	3	2	4	2	3	2	4	3	3	3	4	4
1	61	2	3	2	3	2	3	2	2	2	2	3	2	2	2	1	2
1	62	4	3	4	3	1	3	3	2	2	2	2	1	2	3	1	2
1	63	1	2	3	2	1	1	1	3	2	3	2	1	1	1	2	1
1	64	2	3	2	3	3	4	2	2	3	1	2	2	2	3	3	2
1	65	3	2	3	2	2	4	2	2	2	3	4	2	4	3	5	2
1	66	1	2	2	1	1	1	2	2	2	2	2	1	1	1	1	1
1	67	2	3	2	3	2	2	3	4	3	3	3	2	3	3	5	4
1	68	2	1	2	1	2	2	3	3	3	2	3	2	1	2	2	2
1	69	3	3	3	3	3	3	4	3	3	2	4	2	2	2	2	2
1	70	1	2	1	2	1	2	1	1	2	2	1	1	2	1	3	1
1	71	4	5	3	4	3	4	2	2	3	4	4	2	4	2	5	4
1	72	2	1	1	1	1	2	2	2	2	2	3	2	2	2	3	2
1	73	2	2	1	2	2	2	2	2	2	1	3	2	1	1	2	1
1	74	2	2	1	2	1	2	2	2	2	1	3	2	1	1	2	2
1	75	2	2	1	2	1	2	2	2	2	1	2	2	1	1	2	2
1	76	2	2	2	2	2	4	2	2	2	3	2	2	3	2	4	1

Estimate Table

Estimate_ID	Project_ID	ES_1_4	ES_1_5	ES_1_6	ES_1_7	ES_1_8	ES_1_9	ES_2_1	ES_2_2	ES_2_3	ES_2_4	ES_2_5	ES_2_6	ES_2_7	ES_2_8	ES_2_9	ES_2_10
1	77	1	1	1	2	1	2	1	1	1	1	2	2	1	1	2	1
1	78	1	2	2	2	2	3	2	1	2	2	2	2	2	2	3	2
1	79	1	2	2	2	2	3	2	3	3	2	2	3	2	2	3	1
1	80	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2
1	81	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2
1	82	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2
1	83	2	2	2	2	1	2	2	2	2	2	2	1	1	1	2	2
1	84	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1
1	85	1	1	1	1	2	0	1	1	2	0	1	0	1	0	0	0
1	86	2	3	3	1	2	1	2	2	1	1	2	2	3	3	2	2
1	87	3	2	2	2	3	4	2	3	2	4	4	2	4	2	4	2
1	88	1	2	1	2	1	3	2	2	2	2	1	1	1	1	2	1
1	89	1	0	1	2	1	3	2	2	2	2	4	2	1	1	2	2
1	90	2	2	2	2	1	2	2	2	2	2	2	1	2	1	2	2
1	91	3	2	2	2	3	4	2	3	2	4	4	2	4	2	4	1
1	92	2	3	2	3	2	3	3	3	3	2	1	2	2	1	2	1
1	93	3	2	2	3	2	3	2	2	2	3	3	2	2	2	4	2
1	94	1	2	2	3	2	3	2	2	3	3	1	2	3	2	3	1
1	95	1	1	1	2	2	2	1	1	1	1	1	1	1	2	3	1
1	96	2	2	3	3	2	4	2	2	2	5	2	2	4	3	3	3
1	109	1	3	1	1	1	2	1	2	2	1	2	1	1	1	2	1

Estimate Table

Estimate_ID	Project_ID	ES_2_11	ES_3_1	ES_3_2	ES_3_3	ES_3_4	ES_3_5	ES_3_6	ES_3_7	ES_3_8	ES_3_9	ES_3_10	ES_3_11	ES_3_12	ES_3_13	ES_3_14
1	1	1	1	2	3	1	4	2	2	2	1	1	3	3	3	3
1	2	1	1	1	1	1	1	1	1	1	2	1	2	1	1	4
1	3	1	1	1	1	1	2	1	1	1	2	1	3	1	1	3
1	4	5	1	1	1	1	1	2	2	1	1	1	5	4	2	2
1	5	1	1	1	1	1	1	1	1	3	1	2	1	1	1	2
1	6	1	2	2	1	3	1	3	2	1	1	1	2	1	2	3
1	7	5	2	3	3	3	3	4	4	1	2	1	2	3	5	3
1	8	1	1	2	1	1	1	1	2	1	1	1	2	1	2	1
1	9	4	1	1	1	1	1	2	1	2	1	3	2	1	2	3
1	10	2	2	2	2	1	1	2	2	2	2	2	2	2	2	1
1	11	1	1	1	2	2	2	1	1	2	2	2	1	1	1	2
1	12	5	1	2	2	1	1	3	2	2	1	2	5	1	3	2
1	13	2	2	2	3	1	2	3	3	3	3	3	3	4	3	2
1	14	2	2	3	3	1	2	3	3	2	2	2	2	3	2	2
1	15	1	1	1	1	1	1	1	2	3	2	3	2	2	2	1
1	16	2	4	3	1	2	2	3	1	4	3	3	3	3	3	5
1	17	2	1	2	2	1	2	2	2	1	2	1	3	1	1	2
1	18	4	2	2	4	1	1	2	1	3	1	4	3	2	3	4
1	19	3	2	2	2	2	2	3	1	2	3	2	5	2	2	2
1	20	4	3	1	1	1	4	4	4	4	4	4	5	3	4	3
1	21	4	3	1	1	5	4	4	4	5	4	4	5	3	5	5
1	22	2	2	2	3	1	2	3	1	2	2	3	3	4	3	2
1	23	2	1	1	1	1	2	2	3	1	2	1	3	2	2	3
1	24	1	2	1	1	1	2	3	3	4	2	1	4	2	2	2
1	25	2	2	2	3	1	2	2	1	3	3	2	2	3	2	2
1	26	1	4	1	1	2	2	2	1	1	2	1	2	4	3	2
1	27	2	3	4	1	1	2	5	1	2	3	3	3	3	2	2
1	28	2	2	1	3	1	1	1	1	1	2	1	2	2	2	1
1	29	4	1	2	1	2	3	2	3	1	2	1	1	1	2	2
1	30	1	1	4	4	1	1	1	1	1	4	1	4	3	1	2
1	31	4	1	3	3	1	1	2	1	1	2	1	3	1	1	2
1	32	2	2	1	1	1	2	2	2	2	1	2	4	2	2	2
1	33	2	1	1	1	1	3	2	2	2	2	2	2	2	2	1
1	34	2	2	1	1	1	3	3	3	1	3	1	4	1	4	3
1	35	2	3	3	3	1	2	2	2	4	4	4	5	2	3	2
1	36	2	3	4	3	1	2	4	2	2	4	1	3	4	4	5
1	37	1	1	1	1	2	1	1	2	2	2	2	3	1	3	4
1	38	4	2	0	2	2	2	1	2	2	2	1	2	1	3	2
1	39	4	2	1	1	5	3	3	4	4	3	4	5	3	3	5
1	40	4	2	1	1	1	3	3	3	3	3	3	4	3	3	5
1	41	4	1	1	2	1	1	2	1	3	2	2	3	5	2	3
1	42	2	3	2	2	1	3	3	3	2	3	3	3	3	2	2
1	43	1	1	1	2	1	2	2	1	2	2	2	4	1	3	2
1	44	3	3	1	1	1	2	3	1	2	3	3	2	4	4	1
1	45	3	1	1	4	1	4	3	3	1	2	1	1	3	3	1
1	46	3	1	3	1	1	2	1	3	1	2	1	3	3	3	2
1	47	2	1	1	1	1	2	2	1	2	4	1	5	1	1	1
1	48	3	1	1	1	1	1	1	1	2	2	2	2	1	2	2
1	57	2	2	3	2	1	3	5	4	1	1	1	2	3	5	3
1	58	3	1	2	1	1	1	2	2	1	2	2	1	1	1	1
1	59	3	1	2	2	1	2	2	2	2	2	2	2	1	1	2
1	60	4	1	2	1	1	1	2	2	1	2	2	1	1	2	1
1	61	4	2	2	2	3	3	2	3	2	2	2	3	3	3	2
1	62	4	2	2	2	1	1	2	2	2	2	2	2	3	2	2
1	63	1	1	3	4	3	1	2	1	1	1	2	1	2	1	1
1	64	3	2	2	3	1	1	2	1	2	2	2	2	2	3	2
1	65	1	1	1	1	1	1	1	4	1	1	1	2	4	4	5
1	66	2	1	4	1	1	2	1	1	1	2	3	2	2	2	2
1	67	2	4	3	3	2	2	3	3	4	4	3	4	2	4	4
1	68	2	1	1	1	1	1	1	1	1	1	2	5	2	2	1
1	69	3	2	2	2	2	2	2	2	3	3	2	5	3	3	2
1	70	3	1	1	1	1	2	1	0	1	2	2	3	2	1	1
1	71	3	3	1	1	1	4	3	4	3	5	5	5	5	3	5
1	72	2	1	1	1	2	1	2	2	2	2	2	2	1	1	1
1	73	1	1	1	1	1	2	1	2	1	2	1	1	2	2	1
1	74	1	2	1	1	2	2	2	1	1	2	1	1	2	2	2
1	75	1	2	2	2	1	2	2	2	1	1	1	2	2	2	2
1	76	1	1	1	1	1	2	2	2	2	2	2	2	1	1	1

Estimate Table

Estimate_ID	Project_ID	ES_2_11	ES_3_1	ES_3_2	ES_3_3	ES_3_4	ES_3_5	ES_3_6	ES_3_7	ES_3_8	ES_3_9	ES_3_10	ES_3_11	ES_3_12	ES_3_13	ES_3_14
1	77	1	2	1	1	2	1	1	2	1	1	1	1	2	2	1
1	78	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1	79	3	2	2	2	2	2	2	2	2	2	3	2	2	2	2
1	80	0	1	2	0	2	2	2	2	0	2	2	2	2	2	2
1	81	0	2	2	0	2	2	2	2	0	2	2	2	2	2	2
1	82	0	2	2	2	2	2	2	2	0	2	2	2	2	1	2
1	83	0	2	2	2	2	2	1	2	0	2	2	2	2	1	2
1	84	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1
1	85	1	1	2	3	1	1	1	1	0	2	1	0	1	1	2
1	86	2	2	3	2	2	1	4	4	1	4	1	1	2	3	2
1	87	2	2	4	2	1	1	2	4	1	2	2	2	5	2	2
1	88	1	1	2	2	1	1	1	1	1	2	1	1	5	2	3
1	89	1	4	0	4	1	1	2	2	0	3	2	0	1	3	1
1	90	0	1	0	0	1	1	1	1	0	2	2	2	0	1	2
1	91	1	2	4	2	1	1	2	4	1	2	2	2	5	2	2
1	92	1	1	2	2	1	1	2	2	2	1	1	2	1	2	1
1	93	3	1	1	1	1	1	2	2	1	1	1	1	1	1	1
1	94	1	1	2	2	1	2	2	1	2	2	1	1	2	2	2
1	95	3	1	1	2	1	2	1	1	1	2	1	2	1	1	1
1	96	4	2	1	1	1	1	1	2	1	1	2	1	2	3	3
1	109	1	1	1	2	2	2	2	2	1	2	1	2	2	2	2

Estimate Table

Estimate_ID	Project_ID	ES_4_1	ES_4_2	ES_4_3	ES_4_4	ES_4_5	ES_4_6	ES_4_7	ES_4_8	ES_4_9	ES_4_10	ES_4_11
1	1	1	1	3	4	2	2	3	4	1	1	2
1	2	2	1	1	3	1	2	3	2	1	1	2
1	3	2	1	1	3	3	1	2	3	1	3	3
1	4	2	3	1	5	5	5	5	5	2	5	5
1	5	2	1	3	2	1	1	1	1	2	2	1
1	6	2	2	3	2	2	3	3	2	2	2	3
1	7	3	2	1	1	2	2	3	2	2	5	1
1	8	5	1	1	1	1	1	1	1	3	1	1
1	9	1	1	1	1	1	1	1	1	1	1	1
1	10	5	3	3	3	1	4	4	5	1	2	2
1	11	1	1	3	1	1	1	1	1	1	1	1
1	12	2	1	1	1	3	2	3	3	1	1	2
1	13	2	2	1	2	3	2	2	3	3	2	2
1	14	2	2	1	2	2	3	3	2	2	2	2
1	15	2	1	1	2	2	3	3	2	1	1	1
1	16	3	3	1	3	1	1	3	2	1	1	2
1	17	1	2	1	2	2	1	2	1	2	2	2
1	18	1	1	1	2	2	3	2	4	2	2	2
1	19	3	2	2	2	1	1	2	3	2	1	2
1	20	2	3	3	3	2	3	2	2	2	1	2
1	21	2	3	3	3	2	3	2	2	2	1	2
1	22	2	2	3	4	3	2	4	4	2	2	3
1	23	1	1	1	3	3	1	2	3	1	3	2
1	24	3	3	3	5	4	2	2	4	1	1	3
1	25	2	1	1	2	1	1	2	2	1	1	1
1	26	5	3	1	3	1	1	3	3	1	2	3
1	27	1	1	1	1	1	1	2	1	1	1	2
1	28	1	1	1	2	1	2	2	2	1	2	2
1	29	1	2	1	4	1	2	3	1	1	1	1
1	30	1	1	1	1	1	1	2	2	1	1	1
1	31	1	2	1	1	3	2	2	2	2	3	2
1	32	1	2	1	3	1	1	3	2	1	1	2
1	33	2	2	3	2	2	2	3	2	2	3	2
1	34	3	2	1	4	3	3	2	3	2	3	3
1	35	1	2	1	2	2	2	2	1	1	1	2
1	36	1	2	1	2	2	2	2	1	1	1	2
1	37	3	2	1	3	2	1	2	2	3	2	2
1	38	2	4	1	2	2	3	4	3	2	3	3
1	39	4	2	3	4	2	3	3	3	3	2	3
1	40	4	2	3	4	2	3	3	3	3	2	3
1	41	1	1	1	2	1	2	1	3	1	2	2
1	42	2	2	1	2	3	2	3	2	2	2	2
1	43	1	1	1	1	3	2	2	1	3	2	1
1	44	1	4	3	2	2	1	2	3	1	1	3
1	45	1	2	1	1	1	2	3	3	1	1	4
1	46	1	2	1	1	5	2	1	2	3	1	2
1	47	1	3	3	2	3	3	3	4	2	3	3
1	48	2	2	1	1	1	2	2	1	1	1	1
1	57	2	2	4	3	5	4	4	4	4	3	4
1	58	2	2	1	2	1	1	2	2	2	3	1
1	59	2	2	2	1	2	2	2	2	2	3	2
1	60	2	2	1	1	1	1	4	2	2	3	2
1	61	2	3	3	3	3	2	2	3	3	3	2
1	62	3	2	3	2	1	1	2	2	1	1	2
1	63	1	1	1	2	2	2	2	2	1	2	1
1	64	3	1	2	1	2	2	2	2	2	2	2
1	65	2	2	4	4	3	3	5	5	2	2	2
1	66	1	2	2	1	1	2	2	2	2	2	1
1	67	1	3	1	3	1	3	3	1	1	1	3
1	68	1	2	1	1	2	2	2	1	1	1	1
1	69	2	2	1	1	2	2	2	1	1	2	2
1	70	1	2	1	2	3	1	1	2	2	1	1
1	71	2	3	4	4	4	2	2	3	4	2	4
1	72	2	1	1	1	2	1	2	1	1	2	2
1	73	1	2	1	1	1	1	1	1	1	1	1
1	74	1	2	2	1	2	1	2	1	1	1	2
1	75	1	2	2	2	2	2	2	2	1	1	1
1	76	1	1	2	2	2	3	5	3	2	2	2

Estimate Table

Estimate_ID	Project_ID	ES_4_1	ES_4_2	ES_4_3	ES_4_4	ES_4_5	ES_4_6	ES_4_7	ES_4_8	ES_4_9	ES_4_10	ES_4_11
1	77	1	1	1	1	1	1	1	1	1	1	2
1	78	1	1	1	1	2	1	1	2	2	2	2
1	79	2	2	2	2	2	2	2	2	2	3	2
1	80	1	2	2	2	2	2	2	2	2	0	2
1	81	1	2	2	2	2	2	2	2	2	0	2
1	82	1	2	2	2	2	2	2	2	2	0	2
1	83	2	2	2	2	2	2	2	2	2	0	2
1	84	1	1	1	1	1	1	1	1	2	1	0
1	85	1	3	2	2	1	1	1	3	1	0	0
1	86	2	3	3	1	1	3	3	1	1	1	1
1	87	2	2	2	4	4	3	3	5	2	3	2
1	88	1	1	4	4	1	2	2	5	1	1	1
1	89	1	2	2	3	1	2	2	2	1	2	0
1	90	1	1	1	2	1	1	1	1	1	0	1
1	91	2	2	2	4	4	3	3	5	1	3	2
1	92	2	2	2	2	2	3	3	2	1	2	2
1	93	1	2	4	1	4	2	2	3	4	2	2
1	94	1	2	2	3	2	1	1	2	2	2	2
1	95	1	1	1	1	1	1	1	1	1	1	1
1	96	4	3	2	3	2	1	2	2	3	3	2
1	109	1	1	1	1	1	1	1	1	1	1	1

Operator Table

Operator	Operator_Use
Equal To	=
Not Equal To	<>
Less Than or Equal To	<=
Greater Than or Equal To	>=
Within Range	BETWEEN
Not Within Range	NOT BETWEEN
Contains Character String	LIKE
Does Not Contain Character String	NOT LIKE
Greater Than	>
Less Than	<

Project_Name	Project_ID	Company_Name	Owner_Client	Project_Number	Contact_Person	Contact_Number	Project_Type	Project_Sub_Type	Project_Sub_Type_Other
CII-131-39	1	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	
CII-131-37	2	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	
CII-131-44	3	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	
CII-131-27	4	Confidential	Confidential	Confidential	Confidential		Industrial	Electrical (Generating)	
CII-131-14	5	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-65	6	Confidential	Confidential	Confidential	Confidential		Other	Other	
CII-131-28	7	Confidential	Confidential	Confidential	Confidential		Industrial	Electrical (Generating)	Integrated gasification combined cycle (coal gasification)
CII-131-17	8	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-46	9	Confidential	Confidential	Confidential	Confidential		Industrial	Other	
CII-131-12	10	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-36	11	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	
CII-131-13	12	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	Chemical Mfgr Pilot Plant
CII-131-62	13	Confidential	Confidential	Confidential	Confidential		Industrial	Pulp and Paper	
CII-131-60	14	Confidential	Confidential	Confidential	Confidential		Industrial	Pulp and Paper	
CII-131-04	15	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-22	16	Confidential	Confidential	Confidential	Confidential		Industrial	Electrical (Generating)	
CII-131-31	17	Confidential	Confidential	Confidential	Confidential		Infrastructure	Water/Wastewater	
CII-131-52	18	Confidential	Confidential	Confidential	Confidential		Industrial	Pharmaceuticals Mfgr	Not Provided
CII-131-33	19	Confidential	Confidential	Confidential	Confidential		Industrial	Metals Refining/Processing	
CII-131-63	20	Confidential	Confidential	Confidential	Confidential		Other	Other	
CII-131-64	21	Confidential	Confidential	Confidential	Confidential		Other	Other	
CII-131-55	22	Confidential	Confidential	Confidential	Confidential		Industrial	Pulp and Paper	
CII-131-86	23	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	Machinery in Existing Bldg
CII-131-09	24	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-26	25	Confidential	Confidential	Confidential	Confidential		Industrial	Electrical (Generating)	
CII-131-82	26	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-29	27	Confidential	Confidential	Confidential	Confidential		Industrial	Electrical (Generating)	Gas pipeline facility-gas compression
CII-131-35	28	Confidential	Confidential	Confidential	Confidential		Industrial	Metals Refining/Processing	
CII-131-68	29	Confidential	Confidential	Confidential	Confidential		Building	Laboratory	Truck Loading
CII-131-19	30	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-89	31	Confidential	Confidential	Confidential	Confidential		Other	Other	
CII-131-07	32	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-06	33	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	Process Equipment Replacement
CII-131-45	34	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	Propane Terminal
CII-131-25	35	Confidential	Confidential	Confidential	Confidential		Industrial	Electrical (Generating)	
CII-131-23	36	Confidential	Confidential	Confidential	Confidential		Industrial	Electrical (Generating)	
CII-131-87	37	Confidential	Confidential	Confidential	Confidential		Industrial	Other	
CII-131-88	38	Confidential	Confidential	Confidential	Confidential		Industrial	Pulp and Paper	
CII-131-49	39	Confidential	Confidential	Confidential	Confidential		Industrial	Other	
CII-131-48	40	Confidential	Confidential	Confidential	Confidential		Industrial	Other	
CII-131-51	41	Confidential	Confidential	Confidential	Confidential		Industrial	Other	
CII-131-59	42	Confidential	Confidential	Confidential	Confidential		Industrial	Pulp and Paper	
CII-131-66	43	Confidential	Confidential	Confidential	Confidential		Other	Other	Not Provided
CII-131-34	44	Confidential	Confidential	Confidential	Confidential		Industrial	Metals Refining/Processing	
CII-131-32	45	Confidential	Confidential	Confidential	Confidential		Industrial	Metals Refining/Processing	Natural gas compressor station-reciprocating
CII-131-67	46	Confidential	Confidential	Confidential	Confidential		Other	Other	Not Provided
CII-131-21	47	Confidential	Confidential	Confidential	Confidential		Industrial	Consumer Products Mfgr	
CII-131-56	48	Confidential	Confidential	Confidential	Confidential		Industrial	Pulp and Paper	
CII-131-50	57	Confidential	Confidential	Confidential	Confidential		Industrial	Other	
CII-131-84	58	Confidential	Confidential	Confidential	Confidential		Industrial	Electrical (Generating)	
CII-131-24	59	Confidential	Confidential	Confidential	Confidential		Industrial	Electrical (Generating)	
CII-131-83	60	Confidential	Confidential	Confidential	Confidential		Industrial	Electrical (Generating)	
CII-131-41	61	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	
CII-131-58	62	Confidential	Confidential	Confidential	Confidential		Industrial	Pulp and Paper	
CII-131-57	63	Confidential	Confidential	Confidential	Confidential		Industrial	Pulp and Paper	
CII-131-80	64	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-01	65	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-18	66	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-11	67	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-10	68	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-15	69	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-85	70	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	
CII-131-40	71	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	
CII-131-38	72	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	
CII-131-16	73	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-20	74	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-43	75	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	
CII-131-05	76	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-30	77	Confidential	Confidential	Confidential	Confidential		Industrial	Electrical (Generating)	
CII-131-77	78	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-76	79	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-81	80	Confidential	Confidential	Confidential	Confidential		Building	Other	
CII-131-79	81	Confidential	Confidential	Confidential	Confidential		Building	Other	
CII-131-71	82	Confidential	Confidential	Confidential	Confidential		Building	Other	
CII-131-72	83	Confidential	Confidential	Confidential	Confidential		Building	Other	
CII-131-70	84	Confidential	Confidential	Confidential	Confidential		Building	Other	
CII-131-73	85	Confidential	Confidential	Confidential	Confidential		Building	Other	
CII-131-74	86	Confidential	Confidential	Confidential	Confidential		Building	Other	
CII-131-02	87	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-75	88	Confidential	Confidential	Confidential	Confidential		Building	Other	
CII-131-78	89	Confidential	Confidential	Confidential	Confidential		Building	Other	
CII-131-69	90	Confidential	Confidential	Confidential	Confidential		Building	Other	
CII-131-08	91	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-47	92	Confidential	Confidential	Confidential	Confidential		Industrial	Other	
CII-131-03	93	Confidential	Confidential	Confidential	Confidential		Industrial	Chemical Mfgr	
CII-131-53	94	Confidential	Confidential	Confidential	Confidential		Industrial	Pulp and Paper	
CII-131-54	95	Confidential	Confidential	Confidential	Confidential		Industrial	Pulp and Paper	
CII-131-61	96	Confidential	Confidential	Confidential	Confidential		Industrial	Pulp and Paper	
CII-131-42	109	Confidential	Confidential	Confidential	Confidential		Industrial	Oil Refining	
CII-131-Sample	112	Minneapolis	Minneapolis	Minneapolis	Minneapolis	123-456-7890	Industrial	Chemical Mfgr	

Project Table

Project_Name	Project_ID	Project_Disposition	Project_Disposition_Other	Completed_Project
CII-131-39	1	Grass Roots		TRUE
CII-131-37	2	Grass Roots	Modernization	TRUE
CII-131-44	3	Grass Roots		TRUE
CII-131-27	4	Grass Roots		TRUE
CII-131-14	5	Grass Roots		TRUE
CII-131-65	6	Grass Roots		TRUE
CII-131-28	7	Add-On		TRUE
CII-131-17	8	Grass Roots		TRUE
CII-131-46	9	Modernization		TRUE
CII-131-12	10	Grass Roots		TRUE
CII-131-36	11	Grass Roots		TRUE
CII-131-13	12	Grass Roots		TRUE
CII-131-62	13	Grass Roots		TRUE
CII-131-60	14	Modernization		TRUE
CII-131-04	15	Modernization		TRUE
CII-131-22	16	Grass Roots		TRUE
CII-131-31	17	Modernization		TRUE
CII-131-52	18	Modernization		TRUE
CII-131-33	19	Modernization		TRUE
CII-131-63	20	Add-On		TRUE
CII-131-64	21	Modernization	Revised Process	TRUE
CII-131-55	22	Add-On		TRUE
CII-131-86	23	Grass Roots		TRUE
CII-131-09	24	Modernization		TRUE
CII-131-26	25	Modernization		TRUE
CII-131-82	26	Modernization		TRUE
CII-131-29	27	Grass Roots		TRUE
CII-131-35	28	Add-On		TRUE
CII-131-68	29	Add-On		TRUE
CII-131-19	30	Modernization		TRUE
CII-131-89	31	Other	Not Provided	TRUE
CII-131-07	32	Other		TRUE
CII-131-06	33	Modernization		TRUE
CII-131-45	34	Other	Conversion	TRUE
CII-131-25	35	Other	Rehab	TRUE
CII-131-23	36	Modernization		TRUE
CII-131-87	37	Grass Roots		TRUE
CII-131-88	38	Grass Roots		TRUE
CII-131-49	39	Add-On	Add-On technology to be utilized on an existing blast furnace.	TRUE
CII-131-48	40	Grass Roots		TRUE
CII-131-51	41	Grass Roots		TRUE
CII-131-59	42	Modernization		TRUE
CII-131-66	43	Other	Not Provided	TRUE
CII-131-34	44	Other	New facility on a site with previous utilities, roads, etc.	TRUE
CII-131-32	45	Add-On		TRUE
CII-131-67	46	Other	Not Provided	TRUE
CII-131-21	47	Grass Roots		TRUE
CII-131-56	48	Conversion		TRUE
CII-131-50	57	Conversion		TRUE
CII-131-84	58	Conversion		TRUE
CII-131-24	59	Conversion		TRUE
CII-131-83	60	Conversion		TRUE
CII-131-41	61	Conversion		TRUE
CII-131-58	62	Conversion		TRUE
CII-131-57	63	Conversion		TRUE
CII-131-80	64	Conversion		TRUE
CII-131-01	65	Conversion		TRUE
CII-131-18	66	Conversion		TRUE
CII-131-11	67	Conversion		TRUE
CII-131-10	68	Conversion		TRUE
CII-131-15	69	Conversion		TRUE
CII-131-85	70	Conversion		TRUE
CII-131-40	71	Conversion		TRUE
CII-131-38	72	Conversion		TRUE
CII-131-16	73	Conversion		TRUE
CII-131-20	74	Conversion		TRUE
CII-131-43	75	Conversion		TRUE
CII-131-05	76	Conversion		TRUE
CII-131-30	77	Conversion		TRUE
CII-131-77	78	Conversion		TRUE
CII-131-76	79	Conversion		TRUE
CII-131-81	80	Conversion		TRUE
CII-131-79	81	Conversion		TRUE
CII-131-71	82	Conversion		TRUE
CII-131-72	83	Conversion		TRUE
CII-131-70	84	Conversion		TRUE
CII-131-73	85	Conversion		TRUE
CII-131-74	86	Conversion		TRUE
CII-131-02	87	Conversion		TRUE
CII-131-75	88	Conversion		TRUE
CII-131-78	89	Conversion		TRUE
CII-131-69	90	Conversion		TRUE
CII-131-08	91	Conversion		TRUE
CII-131-47	92	Conversion		TRUE
CII-131-03	93	Conversion		TRUE
CII-131-53	94	Conversion		TRUE
CII-131-54	95	Conversion		TRUE
CII-131-61	96	Conversion		TRUE
CII-131-42	109	Add-On		TRUE
CII-131-Sample	112	Grass Roots		FALSE

Project_Type Table

Project_Type	Project_Sub_Type
Industrial	Electrical (Generating)
Industrial	Oil Exploration/Production
Industrial	Oil Refining
Industrial	Pulp and Paper
Industrial	Chemical Mfgr
Industrial	Environmental
Industrial	Pharmaceuticals Mfgr
Industrial	Metals Refining/Processing
Industrial	Microelectronics Mfgr
Industrial	Consumer Products Mfgr
Infrastructure	Electrical Distribution
Infrastructure	Highway
Infrastructure	Navigation
Building	Lowrise Office
Building	Highrise Office
Building	Warehouse
Infrastructure	Water/Wastewater

ProjectCombo Table

Project_Type	Industrial	Building	Infrastructure	Other	Project_Disposition
Industrial	Electrical (Generating)	Lowrise Office	Electrical Distribution	Other	Conversion
Building	Oil Exploration/Production	Highrise Office	Highway		Add-On
Infrastructure	Oil Refining	Warehouse	Navigation		Grass Roots
Other	Pulp and Paper	Hospital	Flood Control		Modernization
	Chemical Mfgr	Laboratory	Rail		Other
	Environmental	School	Water/Wastewater		
	Pharmaceuticals Mfgr	Prison	Airport		
	Metals Refining/Processing	Other	Tunneling		
	Microelectronics Mfgr		Other		
	Consumer Products Mfgr				
	Other				

Selection Table

Filter	Filter_Use	Field_Type
Project Type	Project.Project_Type	Text
Project Sub-Type	Project.Project_Sub_Type	Text
Project Classification	Project.Project_Disposition	Text
Owner / Customer	Project.Owner_Client	Text
Estimated Engineering Design	Estimate.Estimated_Engineering_Design	Number
Estimated Engineered Equipment	Estimate.Estimated_Engineered_Equipment	Number
Estimated Bulk Materials	Estimate.Estimated_Bulk_Materials	Number
Estimated Owner Costs	Estimate.Estimated_Owner_Costs	Number
Estimated Other Costs	Estimate.Estimated_Other_Costs	Number
Contingency	Estimate.Contingency	Number
Estimated Total	Estimate.Estimated_Total	Number
Actual Engineering Design	Completed_Project.Actual_Engineering_Design	Number
Actual Engineered Equipment	Completed_Project.Actual_Engineered_Equipment	Number
Actual Bulk Materials	Completed_Project.Actual_Bulk_Materials	Number
Actual Construction	Completed_Project.Actual_Construction	Number
Actual Owner Costs	Completed_Project.Actual_Owner_Costs	Number
Actual Other Costs	Completed_Project.Actual_Other_Costs	Number
Actual Total Cost	Completed_Project.Actual_Total	Number
Actual Completion Date	Completed_Project.Actual_Completion	Date/Time
Project ID	Project.Project_Name	Text
Company Name	Project.Company_Name	Text
Estimated Construction	Estimate.Estimated_Construction	Number
Project Location	Project.Project_Number	Text
Estimate Description	Estimate.Estimate_Description	Text
Estimate Date	Estimate.Estimate_Date	Date/Time

StatsField Table

Field	Field_Use
Actual Total Cost	Actual_Total
Estimated Engineered Equipment Costs	Estimated_Engineered_Equipment
Estimated Bulk Materials Costs	Estimated_Bulk_Materials
Estimated Owner Costs	Estimated_Owner_Costs
Estimated Other Costs	Estimated_Other_Costs
Contingency	Contingency
Estimated Total Cost	Estimated_Total
Actual Engineering Design Costs	Actual_Engineering_Design
Actual Engineered Equipment Costs	Actual_Engineered_Equipment
Actual Bulk Materials Costs	Actual_Bulk_Materials
Actual Construction Costs	Actual_Construction
Actual Owner Costs	Actual_Owner_Costs
Actual Other Costs	Actual_Other_Costs
Percent Cost Overrun	Expr2
One	Expr1
Estimated Construction Costs	Estimated_Construction
One Hundred	Expr1
One Million	Expr1
One Thousand	Expr1
Estimated Engineering Design Costs	Estimated_Engineering_Design

StatsOperator Table

Operator	Operator_Use
Divided By	/
Multiplied By	*
Plus	+
Minus	-

Weight Table

Element_Number	1_Weight	2_Weight	3_Weight	4_Weight	5_Weight
ES_1_01	0.1	0.9	1.8	2.7	3.6
ES_1_02	0.0	0.5	0.9	1.4	1.8
ES_1_03	0.0	0.8	1.6	2.4	3.2
ES_1_04	0.0	0.0	0.1	0.1	0.2
ES_1_05	0.0	0.5	1.1	1.6	2.1
ES_1_06	0.0	0.4	0.8	1.2	1.6
ES_1_07	0.0	0.8	1.5	2.3	3.1
ES_1_08	0.0	0.1	0.1	0.2	0.2
ES_1_09	0.0	0.1	0.1	0.2	0.2
ES_2_01	0.0	0.5	0.9	1.4	1.9
ES_2_02	0.0	0.5	1.1	1.6	2.2
ES_2_03	0.0	0.7	1.4	2.1	2.8
ES_2_04	0.0	0.1	0.1	0.2	0.3
ES_2_05	0.2	3.2	6.5	9.7	13.0
ES_2_06	0.0	0.0	0.1	0.1	0.2
ES_2_07	0.0	0.1	0.1	0.2	0.3
ES_2_08	0.0	0.1	0.1	0.2	0.3
ES_2_09	0.0	0.1	0.1	0.2	0.2
ES_2_10	0.0	0.1	0.1	0.2	0.3
ES_2_11	0.0	0.5	1.1	1.6	2.2
ES_3_01	0.1	1.0	1.9	2.9	3.9
ES_3_02	0.0	0.1	0.3	0.4	0.5
ES_3_03	0.0	0.1	0.2	0.3	0.4
ES_3_04	0.0	0.4	0.9	1.3	1.7
ES_3_05	0.1	0.8	1.7	2.5	3.4
ES_3_06	0.0	0.7	1.3	2.0	2.6
ES_3_07	0.0	0.5	1.1	1.6	2.1
ES_3_08	0.1	1.2	2.5	3.7	5.0
ES_3_09	0.1	0.9	1.9	2.8	3.8
ES_3_10	0.1	1.2	2.4	3.6	4.8
ES_3_11	0.0	0.8	1.6	2.5	3.3
ES_3_12	0.0	0.1	0.1	0.2	0.3
ES_3_13	0.0	0.6	1.3	1.9	2.5
ES_3_14	0.1	1.1	2.1	3.2	4.3
ES_4_01	0.1	1.8	3.7	5.5	7.3
ES_4_02	0.0	0.0	0.1	0.1	0.2
ES_4_03	0.0	0.4	0.7	1.1	1.4
ES_4_04	0.0	0.6	1.3	1.9	2.5
ES_4_05	0.0	0.1	0.2	0.2	0.3
ES_4_06	0.0	0.6	1.2	1.8	2.4
ES_4_07	0.0	0.6	1.2	1.8	2.3
ES_4_08	0.0	0.7	1.5	2.2	2.9
ES_4_09	0.0	0.1	0.2	0.3	0.4
ES_4_10	0.0	0.1	0.1	0.2	0.3
ES_4_11	0.0	0.4	0.9	1.3	1.7

Weight Table

Element_Number	Element_Description
ES_1_01	Owner's experience level
ES_1_02	Engineer/Designer's experience level
ES_1_03	Relevant experience of the estimating team
ES_1_04	Level of involvement of the project manager
ES_1_05	Involvement of other resources in preparing estimate
ES_1_06	Review and acceptance of estimate by appropriate parties
ES_1_07	Extent of team integration and alignment
ES_1_08	Purpose and intended use of estimate
ES_1_09	Attitude/culture toward changes
ES_2_01	Completeness of cost information
ES_2_02	Applicability of cost information
ES_2_03	Accuracy and reliability of cost information
ES_2_04	Standard procedure for updating cost information
ES_2_05	Time allowed for preparing the estimate
ES_2_06	Alignment of estimate methodology with available project information
ES_2_07	Is the estimating work process formally defined and followed?
ES_2_08	Formal structure to categorize and prepare the cost estimate
ES_2_09	Utilization of check lists to ensure completeness and technical basis
ES_2_10	Documentation of information used in preparing the estimate
ES_2_11	Method used to determine contingency
ES_3_01	Capacities
ES_3_02	Technology
ES_3_03	Processes
ES_3_04	Site location
ES_3_05	Plot plan
ES_3_06	Utility sources and supply conditions
ES_3_07	Environmental assessment
ES_3_08	Process flow sheets
ES_3_09	Mechanical equipment list
ES_3_10	Heat and material balances
ES_3_11	Piping and instrumentation diagrams (P&&ID's)
ES_3_12	Project strategy
ES_3_13	Project design criteria
ES_3_14	Project schedule
ES_4_01	Owner's costs
ES_4_02	Impact of project type
ES_4_03	Impact of contract type
ES_4_04	Impact of project schedule
ES_4_05	Impact of governmental requirements
ES_4_06	Work force
ES_4_07	Labor productivity
ES_4_08	Bidding climate
ES_4_09	Taxes and insurance
ES_4_10	Money factors
ES_4_11	Logistics for engineering and construction

Weight Table

Element_Number	Help_Question
ES_1_01	What is the level of experience of the owner?
ES_1_02	What is the level of experience of the engineer/designer(s)?
ES_1_03	How relevant is the experience of the estimating team?
ES_1_04	What is the level of involvement of the project manager?
ES_1_05	What was the level of relevant involvement of the listed resources in developing this estimate?
ES_1_06	Were appropriate reviews conducted?
ES_1_07	To what extent have team integration and alignment issues been implemented in preparing this estimate?
ES_1_08	What is the alignment of this estimate?
ES_1_09	What is the attitude/culture toward changes?
ES_2_01	How complete is the cost information used to prepare this estimate?
ES_2_02	How applicable is the cost information to this estimate?
ES_2_03	What is the overall level of accuracy and reliability of the cost information?
ES_2_04	Standard procedure for collection of data (how do you collect your data?)
ES_2_05	Was adequate time allotted to prepare and review this estimate?
ES_2_06	Is there alignment between the estimate methodology and the available project information?
ES_2_07	How well was the estimating work process defined and followed in preparation of this estimate?
ES_2_08	Was a standard format followed during the preparation of this estimate?
ES_2_09	Were appropriate check lists used in the preparation of this estimate?
ES_2_10	Have these issues been documented for this estimate?
ES_2_11	What is the level of risk analysis that was used in preparing this estimate?
ES_3_01	To what extent have the capacities been defined for this project?
ES_3_02	To what extent has the technology been defined for this project?
ES_3_03	To what extent have the processes been defined for this project?
ES_3_04	To what extent has the site location been defined for this project?
ES_3_05	To what extent has the plot plan been defined for this project?
ES_3_06	To what extent have the utility sources been defined for this project?
ES_3_07	To what extent has the environmental assessment been defined for this project?
ES_3_08	To what extent have the process flow sheets been defined for this project?
ES_3_09	To what extent has the mechanical equipment list been defined for this project?
ES_3_10	To what extent have the heat and material balances been defined for this project?
ES_3_11	To what extent have the P&&ID's been defined for this project?
ES_3_12	To what extent has the project strategy been defined for this project?
ES_3_13	To what extent has the project design criteria been defined for this project?
ES_3_14	To what extent has the project schedule been defined for this project?
ES_4_01	To what extent have Owner-cost issues been addressed in preparing this estimate?
ES_4_02	To what extent have project-type issues been addressed in preparing this estimate?
ES_4_03	To what extent have contract-type issues been addressed in preparing this estimate?
ES_4_04	To what extent have project-schedule issues been addressed in preparing this estimate?
ES_4_05	To what extent have governmental-requirement issues been addressed in preparing this estimate?
ES_4_06	To what extent have work-force issues been addressed in preparing this estimate?
ES_4_07	To what extent have labor-productivity issues been addressed in preparing this estimate?
ES_4_08	To what extent have bidding-climate issues been addressed in preparing this estimate?
ES_4_09	To what extent have taxes and insurance issues been addressed in preparing this estimate?
ES_4_10	To what extent have money-factor issues been addressed in preparing this estimate?
ES_4_11	To what extent have logistics issues been addressed in preparing this estimate?

Weight Table

Element_Number	1_Help
ES_1_01	Very high
ES_1_02	Very high
ES_1_03	Relevant experience in almost all areas
ES_1_04	Responsible for execution of project budget and complete agreement with the estimate
ES_1_05	Complete involvement of other resources
ES_1_06	All appropriate reviews conducted
ES_1_07	Almost all issues implemented
ES_1_08	Full agreement on goals and the decisions to be made
ES_1_09	Scope “freeze” points defined and rigidly adhered to
ES_2_01	Almost all of the items are addressed.
ES_2_02	Almost all of the information applies.
ES_2_03	Very high
ES_2_04	Standard procedure for routinely collecting data is followed rigidly
ES_2_05	Sufficient to accomodate changing needs
ES_2_06	Excellent alignment
ES_2_07	Defined and rigidly followed
ES_2_08	Defined and rigidly followed
ES_2_09	Check lists fully utilized
ES_2_10	Almost all of the items documented
ES_2_11	Contingency applied based on a formal risk analysis
ES_3_01	Clearly defined with no deficiencies
ES_3_02	Clearly defined with no deficiencies
ES_3_03	Clearly defined with no deficiencies
ES_3_04	Clearly defined with no deficiencies
ES_3_05	Clearly defined with no deficiencies
ES_3_06	Clearly defined with no deficiencies
ES_3_07	Clearly defined with no deficiencies
ES_3_08	Clearly defined with no deficiencies
ES_3_09	Clearly defined with no deficiencies
ES_3_10	Clearly defined with no deficiencies
ES_3_11	Clearly defined with no deficiencies
ES_3_12	Clearly defined with no deficiencies
ES_3_13	Clearly defined with no deficiencies
ES_3_14	Clearly defined with no deficiencies
ES_4_01	Almost all issues addressed
ES_4_02	Almost all issues addressed
ES_4_03	Almost all issues addressed
ES_4_04	Almost all issues addressed
ES_4_05	Almost all issues addressed
ES_4_06	Almost all issues addressed
ES_4_07	Almost all issues addressed
ES_4_08	Almost all issues addressed
ES_4_09	Almost all issues addressed
ES_4_10	Almost all issues addressed
ES_4_11	Almost all issues addressed

Weight Table

Element_Number	2_Help
ES_1_01	High
ES_1_02	High
ES_1_03	Relevant experience in most areas
ES_1_04	Responsible for execution of budget and highly committed to the estimate
ES_1_05	Major involvement of other resources
ES_1_06	Most
ES_1_07	Most of the issues implemented
ES_1_08	General agreement on goals and the decisions to be made
ES_1_09	History of minor deviations from a no-change philosophy
ES_2_01	Most of the items are addressed.
ES_2_02	Most of the information applies.
ES_2_03	High
ES_2_04	Standard procedure is followed most of the time
ES_2_05	Adequate with some slack
ES_2_06	Good alignment
ES_2_07	Defined and generally followed
ES_2_08	Defined and generally followed
ES_2_09	Extensive use
ES_2_10	Most items documented
ES_2_11	Subjective contingency applied as a percentage of the major cost items
ES_3_01	Defined with minor deficiencies
ES_3_02	Defined with minor deficiencies
ES_3_03	Defined with minor deficiencies
ES_3_04	Defined with minor deficiencies
ES_3_05	Defined with minor deficiencies
ES_3_06	Defined with minor deficiencies
ES_3_07	Defined with minor deficiencies
ES_3_08	Defined with minor deficiencies
ES_3_09	Defined with minor deficiencies
ES_3_10	Defined with minor deficiencies
ES_3_11	Defined with minor deficiencies
ES_3_12	Defined with minor deficiencies
ES_3_13	Defined with minor deficiencies
ES_3_14	Defined with minor deficiencies
ES_4_01	Most of the issues addressed
ES_4_02	Most of the issues addressed
ES_4_03	Most of the issues addressed
ES_4_04	Most of the issues addressed
ES_4_05	Most of the issues addressed
ES_4_06	Most of the issues addressed
ES_4_07	Most of the issues addressed
ES_4_08	Most of the issues addressed
ES_4_09	Most of the issues addressed
ES_4_10	Most of the issues addressed
ES_4_11	Most of the issues addressed

Weight Table

Element_Number	3_Help
ES_1_01	Moderate
ES_1_02	Moderate
ES_1_03	Relevant experience in some areas
ES_1_04	Responsible for execution of budget and generally committed to the estimate
ES_1_05	Some involvement of other resources
ES_1_06	Some
ES_1_07	Some of the issues implemented
ES_1_08	Partial agreement on goals and the decisions to be made
ES_1_09	History of some deviations from a no-change philosophy
ES_2_01	Some of the items are addressed.
ES_2_02	Some of the information applies.
ES_2_03	Moderate
ES_2_04	Standard procedure is followed some of the time
ES_2_05	Adequate without slack
ES_2_06	Fair alignment
ES_2_07	Defined and loosely followed
ES_2_08	Defined and loosely followed
ES_2_09	Some use
ES_2_10	Some items documented
ES_2_11	Contingency applied as standard percentage of the total estimated cost
ES_3_01	Defined with significant deficiencies
ES_3_02	Defined with significant deficiencies
ES_3_03	Defined with significant deficiencies
ES_3_04	Defined with significant deficiencies
ES_3_05	Defined with significant deficiencies
ES_3_06	Defined with significant deficiencies
ES_3_07	Defined with significant deficiencies
ES_3_08	Defined with significant deficiencies
ES_3_09	Defined with significant deficiencies
ES_3_10	Defined with significant deficiencies
ES_3_11	Defined with significant deficiencies
ES_3_12	Defined with significant deficiencies
ES_3_13	Defined with significant deficiencies
ES_3_14	Defined with significant deficiencies
ES_4_01	Some of the issues addressed
ES_4_02	Some of the issues addressed
ES_4_03	Some of the issues addressed
ES_4_04	Some of the issues addressed
ES_4_05	Some of the issues addressed
ES_4_06	Some of the issues addressed
ES_4_07	Some of the issues addressed
ES_4_08	Some of the issues addressed
ES_4_09	Some of the issues addressed
ES_4_10	Some of the issues addressed
ES_4_11	Some of the issues addressed

Weight Table

Element_Number	4_Help
ES_1_01	Low
ES_1_02	Low
ES_1_03	Relevant experience in few areas
ES_1_04	Responsible for execution of budget, but minimum involvement in the estimate
ES_1_05	Minor involvement of other resources
ES_1_06	Few
ES_1_07	Few of the issues implemented
ES_1_08	Limited agreement on goals, but uncertainty over decisions to be made
ES_1_09	Change management procedures not effective in controlling change
ES_2_01	Few of the items are addressed.
ES_2_02	Little of the information applies.
ES_2_03	Low
ES_2_04	No standard procedure, data is collected the same for each estimate
ES_2_05	Marginal or rushed
ES_2_06	Poor alignment
ES_2_07	Vaguely defined and followed
ES_2_08	Vaguely defined and followed
ES_2_09	Little use
ES_2_10	Few items documented
ES_2_11	Contingency applied based on personal past experience
ES_3_01	Major deficiencies and clarifications pending
ES_3_02	Major deficiencies and clarifications pending
ES_3_03	Major deficiencies and clarifications pending
ES_3_04	Major deficiencies and clarifications pending
ES_3_05	Major deficiencies and clarifications pending
ES_3_06	Major deficiencies and clarifications pending
ES_3_07	Major deficiencies and clarifications pending
ES_3_08	Major deficiencies and clarifications pending
ES_3_09	Major deficiencies and clarifications pending
ES_3_10	Major deficiencies and clarifications pending
ES_3_11	Major deficiencies and clarifications pending
ES_3_12	Major deficiencies and clarifications pending
ES_3_13	Major deficiencies and clarifications pending
ES_3_14	Major deficiencies and clarifications pending
ES_4_01	Few of the issues addressed
ES_4_02	Few of the issues addressed
ES_4_03	Few of the issues addressed
ES_4_04	Few of the issues addressed
ES_4_05	Few of the issues addressed
ES_4_06	Few of the issues addressed
ES_4_07	Few of the issues addressed
ES_4_08	Few of the issues addressed
ES_4_09	Few of the issues addressed
ES_4_10	Few of the issues addressed
ES_4_11	Few of the issues addressed

Weight Table

Element_Number	5_Help
ES_1_01	Very low or unknown
ES_1_02	Very low or unknown
ES_1_03	Relevant experience in almost none of the areas
ES_1_04	Not responsible for execution of budget nor involved in the estimate
ES_1_05	Very minor involvement of other resources
ES_1_06	No reviews conducted
ES_1_07	Almost none of the issues implemented
ES_1_08	No agreement on goals or decisions to be made
ES_1_09	No philosophy of change control
ES_2_01	Almost none of the items are addressed
ES_2_02	Almost none of the information applies.
ES_2_03	Very Low
ES_2_04	No standard procedure, data is collected differently for each estimate
ES_2_05	Inadequate
ES_2_06	No alignment
ES_2_07	Not defined
ES_2_08	Not defined
ES_2_09	No check list used
ES_2_10	Almost none of the items documented
ES_2_11	Budget based on estimate with no contingency and no risk analysis
ES_3_01	Incompletely or poorly defined
ES_3_02	Incompletely or poorly defined
ES_3_03	Incompletely or poorly defined
ES_3_04	Incompletely or poorly defined
ES_3_05	Incompletely or poorly defined
ES_3_06	Incompletely or poorly defined
ES_3_07	Incompletely or poorly defined
ES_3_08	Incompletely or poorly defined
ES_3_09	Incompletely or poorly defined
ES_3_10	Incompletely or poorly defined
ES_3_11	Incompletely or poorly defined
ES_3_12	Incompletely or poorly defined
ES_3_13	Incompletely or poorly defined
ES_3_14	Incompletely or poorly defined
ES_4_01	Almost none of the issues addressed
ES_4_02	Almost none of the issues addressed
ES_4_03	Almost none of the issues addressed
ES_4_04	Almost none of the issues addressed
ES_4_05	Almost none of the issues addressed
ES_4_06	Almost none of the issues addressed
ES_4_07	Almost none of the issues addressed
ES_4_08	Almost none of the issues addressed
ES_4_09	Almost none of the issues addressed
ES_4_10	Almost none of the issues addressed
ES_4_11	Almost none of the issues addressed

VITA

Steven M. Trost, P.E.

Candidate for the Degree of

Doctor of Philosophy

Thesis: A QUANTITATIVE MODEL FOR PREDICTING THE ACCURACY OF EARLY COST ESTIMATES FOR CONSTRUCTION PROJECTS IN THE PROCESS INDUSTRY

Major Field: Civil Engineering

Biographical:

Personal Data: Born in North Kansas City, Missouri on June 4, 1969; the son of Michael A. Trost and Jeannine C. Nelson.

Education: Graduated from Kearney R-1 Senior High School, Kearney, Missouri in May, 1987; received Bachelor of Science degree in Civil Engineering from the Massachusetts Institute of Technology, Cambridge, Massachusetts in February, 1991; received Master of Science degree in Civil Engineering from Oklahoma State University, Stillwater, Oklahoma in July, 1996; completed requirements for Doctor of Philosophy degree in Civil Engineering at Oklahoma State University in December, 1998.

Professional Experience: Assistant Program Manager, 1998 to present; Senior Civil Engineer, 1997 to 1998; Graduate Research Associate 1996 to 1998; Staff Civil Engineer, 1995 to 1997; Assistant Civil Engineer, 1991 to 1995.

Professional Affiliations: Registered Professional Engineer–Missouri E-27265; Chi Epsilon Honor Fraternity; Phi Kappa Phi Honor Society; Association for the Advancement of Cost Engineering International.